BIOENERGY RESEARCH AND DEVELOPMENT

A Summary of the Federal Program
From
April 1981 to March 1982

Compiled and Edited by

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and
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of the
Bioenergy Program

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RESOURCE ASSESSMENT

PROJECT DATA

141

TITLE Development of a Biomass Model to estimate quantity of biomass following logging, in B.C. forests, to specified recovery criteria

CONTRACT # KL017-9-655 (OSB80-1) P-142

ORGANIZATION Talisman Projects Incorporated
842 Thurlow Street, 3rd Floor
Vancouver, B.C.
V6E 1W2

PRINCIPAL INVESTIGATOR D.E. Schroeter

DURATION April 1980 - March 1983

COST $417,500

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY G.H. Manning
Pacific Forest Research Centre
Canadian Forestry Service
506 West Burnside Road
Victoria, B.C.
V8Z 1M5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$ 85,000			$ 85,000
1981-82	$160,000			$160,000
1982-83	$172,500			$172,500

REPORTS

OBJECTIVE

1. To develop a system for estimating biomass per ha (total and component parts) as a function of designated recovery criteria, thereby enabling an investigation of optimum harvesting plans balancing biomass production with production of conventional forest products.

2. To develop this system where possible around existing B.C. Ministry of Forests inventory data and procedures.

3. To develop, as a necessary part of this system, improved individual tree component biomass relationships.

DESCRIPTION

Proposed Approach: The consultant will choose a sample of 1,000 trees in B.C., well distributed by species, site range, and diameter class, where possible in cooperation with the B.C. Ministry of Forests. The trees will be measured, felled, weighed and sampled for moisture content. Biomass weight equations will be prepared by component and species. He will gather, from Ministry sources, appropriate information on proportion of biomass in non-commercial trees, waste and breakage data, and merchantable volume factors. He will integrate these data into a simulation model which will predict, for any level of commercial utilization, the residue which will remain after logging; and he will test said model under actual conditions.

STATUS AND COMMENTS

PROJECT DATA

143

TITLE Data for Biomass Prediction Equation - N.B. & N.S.

CONTRACT # KL003-0-0007 (OSC80-3) P-159

ORGANIZATION Woodlot Service Limited
320 Maple Street
Fredericton, N.B.

PRINCIPAL INVESTIGATOR G.B. Young

DURATION April 1980 - March 1983

COST $240,000

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY G.D. van Raalte
Maritimes Forest Research Centre
Canadian Forestry Service
P.O. Box 4000
Fredericton, N.B.
E3B 5P7

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$80,000			$80,000
1981-82	$89,000			$89,000
1982-83	$71,000			$71,000

OBJECTIVE

To determine green weights for whole and component parts of balsam fir, red/black spruce, white spruce, jack pine, red maple, aspen and white birch.

DESCRIPTION

Some 1400 individual trees will be selected from 200 random sample areas in New Brunswick (120) and Nova Scotia (80). These areas will be selected by M.F.R.C. From each sample area, 1 tree of each of the 7 species mentioned above will be selected, and its height, diameter, and crown dimensions measured. Each tree will then be processed in a standard manner prescribed by M.F.R.C. Appropriate samples will be removed from all above-ground parts of the tree (stem, branches, foliage, etc.) and transported to Fredericton for further processing.

REPORTS

STATUS AND COMMENTS

4.3.1.3 Biomass Resource Assessment/Forestry - Biomass Factors. 31/3/82

PROJECT DATA

160

TITLE Literature Survey - Growth & Yield of Different Tree Species and Other Vegetation in the Boreal Zone

CONTRACT # KL015-9-335 (08880-70) P150

ORGANIZATION Western Ecological Services Ltd.
9865 West Saanich Road
R.R.#2 Sidney, B.C.
V8L 3S1

PRINCIPAL INVESTIGATOR K.R. Peterson

DURATION April 1980 - March 1982

COST $40,000

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY J.M. Powell
Northern Forestry Research Centre
CFS, Environment Canada
5320-122 Street
Edmonton, Alberta
T6H 3S5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$12,858			$12,858
1981-82	$17,144			$17,144

OBJECTIVE

1. To evaluate the interrelationships between key climatic parameters and measures of biomass productivity in forest and adjacent agricultural lands.
2. To assemble relevant biomass productivity and climatic data and to initiate development of regional data bank, such that the information may be used to project effect of climate and climate fluctuations on biomass productivity.
3. To identify data gaps for future studies in the area of short and long-term climate/biomass productivity inter-actions in the Boreal Forest Zone of the Western and Northern Region.

Many benefits will result from an ability to predict impact of different scales of climatic variations on biomass parameters of the Boreal forest, which will help minimize the deleterious impacts of such changes on our forest/energy economy and maximize the return from each land unit. Such information will benefit all elements of Canadian forestry activity and will have widespread application in other socio-economic areas.

DESCRIPTION

Carry out a literature survey of measures of biomass parameters in the Boreal Forest Zone in North America and elsewhere especially with reference to climatic parameters and their inter-relationships with biomass productivity. The survey will involve providing an annotated summary of each source suitable for input to a computerized biomass information system. A further major aspect is to identify information gaps of short and long-term climate/biomass productivity interactions and propose future studies to help fill these gaps so that adequate predictions can be made concerning biomass productivity and climatic fluctuations in the Boreal Forest Zone.

REPORTS

STATUS AND COMMENTS

4.3.1.3 Biomass Resource Assessment/Forestry - Biomass Factors. 19/04/82

PROJECT DATA

161

TITLE Computer-based Mapping for Forest Biomass Inventory - P140

CONTRACT #

ORGANIZATION Statistics Canada
Geocartographics Group
Jean Talon Building, Tunney's Pasture
Ottawa, Ontario. K1A 0T6

PRINCIPAL INVESTIGATOR R.A. Cunningham

DURATION April 1981 - March 1982

COST $124,000

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY Dr. G.M. Bonner
Petawawa National Forestry Institute
Environment Canada
Chalk River, Ontario
K0J 1J0

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$35,000			$35,000
1981-82	$89,000			$89,000

OBJECTIVE

To implement nationally the Canadian Forest Resource Data System (CFRDS): complete the development of a continuous, computerized system for accumulating, storing, retrieving and mapping forest resource data, and obtain data which are essential for estimating forest biomass resources in Canada.

DESCRIPTION

Accurate and up-to-date statistical information about the extent, quantities, growth, yield, losses, and health of Canada's forest resources is inadequate for today's needs of national forest policy and decision-making for optimum use. The present urgent needs for energy conservation and the development of forest biomass as an energy source also demand efficient and rapid means of defining its quantity, form and location. This proposal is to substitute the CFRDS for the questionnaire approach that the Federal Government has used over the past 35 years, to collect forestry data from provincial forest inventory agencies at more or less five-year intervals, and to compile national statistics by summarizing the returns. At the same time a continuous, national forest biomass inventory can be made.

Systems Development: To complete development of the computerized data handling and mapping system, software packages and equipment must be purchased and the components integrated.

Data Acquisition and Input: Data from forestry agencies (mostly provincial) across Canada will be obtained, converted to fit the national classification system and stored on computer.

REPORTS

STATUS AND COMMENTS

4.3.1.3 Biomass Resource Assessment/Forestry - Biomass Factors.

PROJECT DATA

163

TITLE Biomass Prediction Equations for Yukon Tree Species

CONTRACT # KL017-9-1150 (OSB80-69) P141

ORGANIZATION Nawitka Renewable Resources Consultants Ltd.
836-840 Cormorant Street
Victoria, B.C. V8W 1R1

PRINCIPAL INVESTIGATOR M.R.C. Massie

DURATION April 1980 - March 1982

COST $146,657

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY G.H. Manning
Pacific Forest Research Centre
Canadian Forestry Service
506 West Burnside Road
Victoria, B.C.
V8Z 1M5
(604) 388-3811 ext. 157

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$74,402			$74,402
1981-82	$72,255			$72,255

OBJECTIVE

1. To develop weight prediction equations for the main potentially commercial tree species in the Yukon Territory, from standard tree measurements.
2. To further the development of field and analytical techniques for this purpose.

DESCRIPTION

The project report will include:

- appropriate summaries of the basic data
- green weight equations, by component, species, ecoregions
- dry weight equations, by component, species, ecoregions
- stem volume equations (to 2.5 cm top)
- summary equations for green weight and dry weight for Yukon, by component and species
- a description and critical analysis of the techniques used, and if appropriate, recommendations for future development.

REPORTS

STATUS AND COMMENTS

4.3.1.3 Biomass Resource Assessment/Forestry - Biomass Factors. 19/04/82

PROJECT DATA

165

TITLE Impact of Climatic Variation on Boreal Forest Biomass Through Use of Tree-Ring Analysis

CONTRACT # KL015-9-332 (OSS80-63) P149

ORGANIZATION Forintek Canada Corporation
Western Laboratory
6620 NW Marine Drive
Vancouver, B.C. V6T 1X2

PRINCIPAL INVESTIGATOR M.L. Parker

DURATION April 1980 - March 1982

COST $42,000

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY J.M. Powell
Northern Forest Research Centre
CFS
Environment Canada
5320-122 Street
Edmonton, Alberta
T6H 3S5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$18,000			$18,000
1981-82	$24,000			$24,000

OBJECTIVE

To undertake a pilot study to examine the use of tree ring chronologies to provide information on the impact of climatic variation on Boreal forest biomass productivity for two transects of five sites through the Boreal forest and adjacent zones using white spruce as the sample species.

DESCRIPTION

One transect would be in the Alberta/NWT area and the other in the Saskatchewan/Manitoba/NWT area. Two trips in each area would likely be necessary for reconnaissance to select sites and collect the samples. Tree disks and cores would be obtained from 10 - 15 trees at each site on the transect and at various heights on the trees. Two average radii from each sample will be prepared for x-ray densitometry analysis to derive ring-width, ring-density chronologies and biomass data. Data will be put on tape using a data acquisition and other programs, such that all data can be subsequently analyzed for various output parameters from which growth trends have been removed. Established techniques will be used throughout the sampling, preparation for x-ray densitometry and analysis of data to provide a report of processed tree ring witdth and density data appropriate for climatic and biomass analysis. Collection and analysis of data from one transect should be completed in the first year.

REPORTS

STATUS AND COMMENTS

4.3.1.3 Biomass Resource Assessment/Forestry - Biomass Factors. 19/04/82

PROJECT DATA

205

TITLE Pilot Regional Biomass Inventory System

CONTRACT # 41SS-KL015-0-0102 (OSS80-139) P-148

ORGANIZATION Systemhouse
2827 Riverside Drive
Ottawa, Ontario
K1V 0C4

PRINCIPAL INVESTIGATOR

DURATION April 1980 - March 1983

COST $246,501

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY C.L. Kirby
Northern Forest Research Centre
Canadian Forestry Service
5320-122nd Street
Edmonton, Alberta
T6H 3S5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$108,516			$108,516
1981-82	$ 65,985			$ 65,985
1982-83	$ 72,000			$ 72,000

OBJECTIVE

1. To provide pilot study of a computerized interactive information system for biomass inventories suitable for provincial needs and compatible with national resource data systems.
2. To provide an in-house biomass data base to be used for regional and national requirements.
3. To demonstrate the usefulness of Landsat and large-scale photo sampling in a multi-stage sampling design for estimating biomass.

DESCRIPTION

A one million hectare data base for Alberta, Saskatchewan, Manitoba, and the Northwest Territories will be developed using the forest inventory data obtained from Alberta and Saskatchewan, Landsat imagery, large-scale photo samples and regional biomass prediction equations. Thus, the biomass of various forest covertypes will be estimated through a computerized system whose output and format will be sufficiently flexible to satisfy resource management goals for timber, wildlife, recreation, and water. The data base will be compatible with that proposed by the Canadian Forestry Service.

Phase I (1980-81) Assessment and development of the hardware and software required for pilot-scale demonstration. Development and operation of the computerized management system.
Phase II (1981-83) Conduct the demonstration and process the data.

REPORTS

STATUS AND COMMENTS

4.3.1.3 Biomass Resource Assessment/Forestry Biomass Factors.

PROJECT DATA 213

TITLE Determination of Biomass and Nutrient Content in Trees, Ground Vegetation and Soil of Aspen Stands in Alberta

CONTRACT # KL015-1-0012(OSS81-00114) C-205

ORGANIZATION Alan Moss and Associates Ltd.
1334 St. Paul Street
Kelowna, B.C.
V1Y 2E1

PRINCIPAL INVESTIGATOR

DURATION August 1981 - March 1984

COST $393,691

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY L.G. Brace
Northern Forest Research Centre
C.F.S.
5320 - 122 Street
Edmonton, Alberta T6H 3S5

TECHNICAL LIAISON OFFICER: Mr. I.K. Edwards
Northern Forest Research Centre
Edmonton, Alberta
T6H 3S5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$ 41,827			$ 41,827
1982-83	$301,386			$301,386
1983-84	$ 30,478			$ 50,478

REPORTS

OBJECTIVE

The major objective of this project is to determine biomass and nutrient content of trees, understory vegetation, forest floor and mineral soil within aspen stands of the Mixedwood region. These data (along with tree data being collected) will be necessary to assess fully the effect of whole tree removal on the nutrient budget within this type of forest ecosystem. The latter information will be useful in assessing the availability of soil nutrients for the succeeding tree crop.

DESCRIPTION

Field work will consist of identification and sampling description of representative aspen stands of fire origin in each Prairie Province. The total number of stands will be proportional to the distribution of aspen in each province. There will be 18 plots, 2 for each of 3 age and 3 site classes.

There will be a maximum of two tree species sampled (aspen and poplar) in each age and site class, with 4 samples per species to cover the diameter range by 4 groupings as used in ENFOR Project P-92. This will give a maximum sample of 72 trees in each species. Each stand sampled will be at least 75% hardwood, 50% of which must be aspen by volume.

Field sampling must be restricted to the time period July 15 to September 15 to minimize fluctuations in nutrient concentration of tree components in the sample.

Tree sampling will follow the procedure used in ENFOR Project P-92, with the addition of root information. Components sampled will therefore be stump, roots, merchantable and non-merchantable stem, branches, and foliage. Ground vegetation will be sampled also. Wood, branches, roots, foliage and ground vegetation will be analyzed for N, P, K, Ca, and Mg.

At each plot, samples of the forest floor and each of three horizons of mineral soil will be sampled. These will be analyzed for pH, electrical conductivity, texture, bulk density, organic matter, N, P, K, Ca, Mg, Na, and available water capacity. These data will be used to determine biomass and nutrient content on an area basis.

Data sufficient to compute stem wood volume and crown and root mass for each tree sample, following ENFOR P-92 procedures, will be taken. Forms for these data and for all other biomass and nutrient sampling data will be provided.

Stand and site description forms which will provide linkages to the bio-geo-climatic survey currently underway in the region will be provided for use in this contract.

STATUS AND COMMENTS

4.3.1.3 Biomass Resource Assessment/Forestry-Biomass Factors. 28/3/82

PROJECT DATA

218

TITLE Biomass Studies on the Black Spruce in Québec

CONTRACT # KL004-1-C-007 (OSD81-00033) P-225

ORGANIZATION Groupe Poulin Thériault Ltée
3350 Boul. Wilfred Hamel
Québec, Québec
G1P 2J9

PRINCIPAL INVESTIGATOR

DURATION June 1981 - October 1981

COST $30,000

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY Denis Ouellet
Laurentian Forest Research Centre
Environment Canada
P.O. Box 3800
Route du Valon
Ste. Foy, Québec
G1V 4C7

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$30,000			$30,000

REPORTS

OBJECTIVE

The principal objective is to establish regression equations for black spruce in the Chibougamou region. The equations will permit the prediction of the mass of the different components of the trees (branches, trunk, etc.) from the different parameters (diameter, height, etc.).

DESCRIPTION

1. To obtain information and coordinates of the sample plot.
2. To establish the sample plot (0.04 ha in area) in the selected area.
3. To list the number of stems classed by d.b.h. for every 2 cm increase for stems greater than 9 cm d.b.h. measured 1.3 m above the soil.
4. To list the number of stems classed for d.b.h. of 2, 4, 6 and 8 cm.
5. For the stems with d.b.h. less than 1 cm, list the number of stems classed by height of 10 to 50 cm, 51 to 100 cm, and 101 to 150 cm.
6. Calculate the number of stems classed by diameter and determine the relative importance of each.
7. Choose sample stems among the living trees for each class of d.b.h.
8. Measure 5 different heights of trees classed by diameter.
9. Cut down the stems with a diameter greater than 9 cm at 30 cm above ground.
10. Cut down the stems with d.b.h. of less than 9 cm and greater than 1 cm.

STATUS AND COMMENTS

4.3.1.3 Biomass Resource Assessment/Forestry - Biomass Factors. 21/3/82

PROJECT DATA

225

TITLE	Coordination of ENFOR biomass estimation projects, and development of biomass estimates based on provincial timber inventories
CONTRACT #	KL229-1-4260 (OSS81-00092) P-227
ORGANIZATION	T.M. Thomson & Associates Ltd. 1006 Government Street Victoria, B.C. V8W 1X7
PRINCIPAL INVESTIGATOR	W.A. Hopwood
DURATION	July 1981 - March 1983
COST	$184,000
SPONSOR	Environment Canada
SCIENTIFIC AUTHORITY	Dr. T.G. Honer Pacific Forest Research Centre Environment Canada 506 West Burnside Road Victoria, B.C. V8Z 1M5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82 1982-83	$ 84,000 $100,000			$ 84,000 $100,000

OBJECTIVE

To coordinate the development of biomass estimation equations, and their application to the forest inventory data of all provinces in order to generate forest biomass estimates according to specifications of the Canadian Forest Resource Data System.

DESCRIPTION

1. Review biomass estimation project proposals and make recommendations for support.
2. Coordinate biomass estimation projects within the CFS by maintaining liaison with regional establishments, and by monitoring progress in developing and testing procedures to convert timber inventories to biomass estimates.
3. Develop minimum criteria for biomass inventories and methods for inventory conversion to mass estimates.
4. Plan and facilitate biomass pilot projects with the Canadian Forest Resource Data System.
5. Establish national and regional data bases for the storage of biomass data gathered on ENFOR projects.
6. Prepare comprehensive reports on work accomplished, and document field and office (software) procedures.

REPORTS

STATUS AND COMMENTS

For previous work refer to project data sheet 208 (P219).

4.3.1.3 Biomass Resource Assessment/Forestry - Biomass Factors.

21/3/82

PROJECT DATA

167

TITLE Rate of Biomass Growth and Production in Plantations

CONTRACT # kL033-0-008 (OSC80-00027) P158

ORGANIZATION Dept. of Forest Research & Fire Science
University of New Brunswick
Fredericton, N.B.

PRINCIPAL INVESTIGATOR Dr. I. Methven

DURATION April 1980 - March 1982

COST $43,726

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY G.D. van Raalte
Maritime Forest Research Centre
Environment Canada
P.O. Box 4000, College Hill
Fredericton, N.B.

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$22,466			$22,466
1981-82	$21,260			$21,260

OBJECTIVE

To determine the rates of growth of biomass in young stands (up to 25 years of age) of plantation origin, and to compare these to the rates of growth of young stands of natural origin (P-41), for energy management purposes.

DESCRIPTION

All work is to be carried out in North Eastern New Brunswick where suitable plantations (age and species) have been extensively planted. The work requires close contact and co-operation between MFRC and the contractors. The work constitutes the second part of a program to determine the rate of growth of biomass in young stands of different species and origins. The UNB Department of Forest Resources is already engaged in a two year contract carrying out the work involved in the first phase of this program, i.e. to determine the rate of biomass growth in stands of natural origins. The methodology, techniques, equipment and expertise have been developed during the first phase of this work by the Department of Forest Resources.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

206

TITLE Hardwood Coppice Silviculture

CONTRACT # 09SD-KL004-0-C016 (OSD80-47) P-154

ORGANIZATION Perreault Larouche Houde Associés
376 du Roi, Room 307
Québec, Québec
G1X 2W6

PRINCIPAL INVESTIGATOR A. Perreault

DURATION 2 years

COST $51,034

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY H. Roberge
Laurentian Forest Research Centre
Ste-Foy, Québec
(418) 653,3776

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$36,034			$36,034
1981-82	$15,000			$15,000

OBJECTIVE

1. To test methods and concepts of coppice management and silviculture of existing hardwood stands.
2. To study the potential and feasibility of producing brushwood for energy.

DESCRIPTION

Using existing stands, the above-ground biomass will be calculated using various harvesting mehtods, and species growing on different soils. Prior to harvesting, the natural densities will be determined so that the ideal density can be determined relative to soil and harvesting variables, once the artificially increased densities are known in the 2nd year of the project.

REPORTS

STATUS AND COMMENTS

4.3.1.4 Biomass Resource Assessment/Forestry - Energy Plantations - Productivity. 21/3/82

PROJECT DATA

149

TITLE Agricultural and Other Biomass Wastes as a Source of Energy

CONTRACT # 31155-0-2664 (095X.31155-02664)

ORGANIZATION Technical University of Nova Scotia
Center for Energy Studies
P.O. Box 1000
Halifax, Nova Scotia B3J 2X4

PRINCIPAL INVESTIGATOR D. Procos

DURATION November 1980 - March 1982

COST $69,563

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Dr. R.P. Overend
National Research Council
Building M-50
Ottawa, Ontario
K1A 0R6
(613) 993-3405

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$20,905			$20,905
1981-82	$48,658			$48,658

REPORTS

OBJECTIVE

To explore the extent to which waste biomass from agriculture, municipal wastes, and forestry could be useful as an energy source in rural and urban settings across Canada

DESCRIPTION

1. To identify and quantify the distribution, across Canada, of agricultural wastes.
2. To investigate and calculate the available amounts of other biomass resources, such as forestry wastes and municipal solid waste.
3. To establish the quantities of agricultural and/or other biomass wastes that must remain on the farm for soil amendment.
4. To identify significant fluctuations in supply for the biomass wastes under consideration.
5. To investigate transportation costs and means of conveyance for unprocessed biomass products.
6. To identify specific end uses of energy to be found in the residential, commercial, and industrial sectors, as well as the transportation sector.
7. To conduct a survey of biomass conversion technology available.
8. To estimate market income to farmers and other producers from the sale of biomass residues.
9. To investigate inefficiencies in the system.
10. To evaluate the substitution of biomass energy in terms of cost and security of supply.
11. To discuss non-energy implications
12. To set out recommendations for policies and programs.

STATUS AND COMMENTS

The contract was amended in January 1982 to identify the opportunities for the biomass conversion technologies in the processing industries, which can probably effectively "cogenerate" energy along with their production.

PROJECT DATA

251

TITLE Assessment of the Potential for a Sustained Energy Supply from the Agriculture and Food System for the British Columbia and Prairie Regions

CONTRACT # 01843-1-ER09/1 (OSZ81-00097)

ORGANIZATION Canadian Resourcecon Limited
Mayland Office Park 2
#205 - 825 Manning Gardens N.E.
Calgary, Alberta T2E 7L4

PRINCIPAL INVESTIGATOR

DURATION November 24, 1981 - March 15, 1982

COST $63,766

SPONSOR Agriculture Canada

SCIENTIFIC AUTHORITY Dr. M. Colwell
Energy Analysis and Policy
Production Development Policy Directorate
Agriculture Canada
Ottawa, Ontario
K1A 0C5
(613) 995-9554

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$63,766			$63,766

OBJECTIVE

The project should achieve the objective of assessing the potential for a sustained energy supply from the agriculture and food system for British Columbia and the Prairie regions.

DESCRIPTION

1. Develop a highly disaggregated inventory of agri-food system based energy feedstocks. The inventory should indicate location, seasonality and net availability. Net availability requires consideration of existing requirements e.g. recycling of part of crop residues back to the soil.
2. Evaluating feedstocks and end product energy forms in the context of available conversion routes.
3. Evaluating the economics of energy supply.
4. Identifying the realistic potential for regionally-based energy supply from the agri-food system.
5. Identifying and assessing constraints limiting attainment of the potential.

REPORTS

STATUS AND COMMENTS

4.3.1.6 Biomass Resource Assessment/Agriculture - Plant Residues. 18/3/82

PROJECT DATA

252

TITLE Assessment of the Potential for a Sustained Energy Supply from the Agriculture and Food System for the Québec Region.

CONTRACT # 01843-1-ER09/3

ORGANIZATION Roche Associés Ltée.
2535 boul. Laurier
Sainte-Foy, Québec
G1V 4M3

PRINCIPAL INVESTIGATOR

DURATION December 1981 - March 15, 1982

COST $51,216

SPONSOR Agriculture Canada

SCIENTIFIC AUTHORITY Dr. M. Colwell
Energy Analysis and Policy
Production Development Policy Directorate
Agriculture Canada
Ottawa, Ontario
K1A 0C5
(613) 995-9554

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$51,216			$51,216

OBJECTIVE

The project should achieve the objective of assessing the potential for a sustained energy supply from the agriculture and food system for the Québec region.

DESCRIPTION

1. Develop a highly disaggregated inventory of agri-food system based energy feedstocks. The inventory should indicate location, seasonality and net availability. Net availability requires consideration of existing requirements e.g. recycling of part of crop residues back to the soil.
2. Evaluating feedstocks and end product energy forms in the context of available conversion routes.
3. Evaluating the economics of energy supply.
4. Identifying the realistic potential for regionally-based energy supply from the agri-food system.
5. Identifying and assessing constraints limiting attainment of the potential.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

253

TITLE Assessment of the Potential for a Sustained Energy Supply from the Agriculture and Food System for the Ontario Region.

CONTRACT # 01843-1-ER09/2 (OSZ81-00099)

ORGANIZATION Deloitte Haskins & Sells Associates
380 Woolwich Street
Guelph, Ontario
N1H 3W7

PRINCIPAL INVESTIGATOR

DURATION January 8, 1982 - February 28, 1982

COST $43,585

SPONSOR Agriculture Canada

SCIENTIFIC AUTHORITY Dr. M. Colwell
Energy Analysis and Policy
Production Development Policy Directorate
Agriculture Canada
Ottawa, Ontario
K1A 0C5
(613) 995-9554

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$43,585			$43,585

REPORTS

OBJECTIVE

The project should achieve the objective of assessing the potential for a sustained energy supply from the agriculture and food system for the Ontario region.

DESCRIPTION

1. Develop a highly disaggregated inventory of agri-food system based energy feedstocks. The inventory should indicate location, seasonality and net availability. Net availability requires consideration of existing requirements e.g. recycling of part of crop residues back to the soil.
2. Evaluating feedstocks and end product energy forms in the context of available conversion routes.
3. Evaluating the economics of energy supply.
4. Identifying the realistic potential for regionally-based energy supply from the agri-food system.
5. Identifying and assessing constraints limiting attainment of the potential.

STATUS AND COMMENTS

PROJECT DATA

216

TITLE Assessment of Lunaria as a Prospective Crop for Energy Production

CONTRACT # 34SZ.1843-1-ER01 (08Z81-58)

ORGANIZATION Enersearch
C/O Federated Cooperative Ltd.
401-22nd Street
Saskatoon, Saskatchewan
S7K 3M9

PRINCIPAL INVESTIGATOR Brian Dykes (244-3300)

DURATION October 1981 - May 1983

COST $10,000

SPONSOR Agriculture Canada

SCIENTIFIC AUTHORITY M. Stumborg
Agriculture Canada, Research Branch
Research Station
Swift Current, Saskatchewan
S9H 3Z2
(613) 773-4621

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$ 5,000			$ 5,000
1982-83	$ 5,000			$ 5,000

REPORTS

OBJECTIVE

To assess Lunaria as a prospective crop for fuels and industrial oils.

DESCRIPTION

Phase 1

1. The contractor shall conduct a comprehensive literature search on Lunaria sp. related to its agronomic properties and potential uses as industrial chemicals and fuels.
2. The contractor shall obtain quantity of Lunaria annua and biennis to initiate laboratory analysis and plant field test plots.
3. The contractor shall perform laboratory analysis including extraction of the seed oil and the determination of % content, composition by GLC of its methyl esters, viscosities, density, and calorific value.
4. The contractor shall examine the residual meal to determine the nature and levels of the glucosinolates present, the protein, crude fibre and ash content, ADF/NDF analysis and amino acid composition of the meal.

Phase 2

1. The contractor will design a field trial test plan in collaboration with the scientific authority and other Agriculture Canada staff as required. The test plan will include details of the planting configuration and assessment of potential yield, agronomic properties such as maturity, height, or others as mutually agreed to by the scientific authority and the contractor. The field trials will be sufficiently large to provide a seed supply required for potential future large scale field trials.

STATUS AND COMMENTS

PROJECT DATA

217

TITLE Assessment of Milkweed as a Potential Renewable Energy Crop

CONTRACT # 34SZ.1843-1-ER02 (OSZ81-69)

ORGANIZATION Energsearch
C/O Federated Cooperative Ltd.
401-22nd Street
Saskatoon, Saskatchewan
S7K 3M9

PRINCIPAL INVESTIGATOR Brian Dykes (244-3300)

DURATION October 1981 - October 1982

COST $65,000

SPONSOR Agriculture Canada

SCIENTIFIC AUTHORITY M. Stumborg
Agriculture Canada, Research Branch
Research Station
Swift Current, Saskatchewan
S9H 3Z2
(613) 773-4621

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$30,000			$30,000
1982-83	$35,000			$35,000

OBJECTIVE

To assess the potential of milkweed as an energy crop.

DESCRIPTION

Phase 1 The contractor will design a field trial test plan in collaboration with the scientific authority and other Agriculture Canada staff as required. The test plan will be designed within the bounds of the milkweed seed plantings that were established by the contractor during the fall of 1980. The test plan will include details of agronomic practices (e.g. optimum levels of fertilizer, irrigation, weed control, etc. versus non-intensive levels of agronomic inputs, and multiple harvests versus single harvest), agronomic properties (e.g. maturity, yield, soil analysis, dry matter, etc.) and chemical properties (e.g. fiber, ash, in vitro digestibility, protein content of the residual biomass, extractable crude oil, C/H/N analysis, calorific content, and if possible chemical composition and molecular weight distribution).
Phase 2 The contractor will design an animal feeding trial test plan in collaboration with the scientific authority and other Agriculture Canada staff as required. The test plan will be designed to investigate the feed value of oil extracted milkweed residue in terms of palatability, toxicity, digestibility, or other parameters.
Phase 3
The contractor will: 1) carry out the field trial test plan as described in Phase 1; 2) carry out the animal feeding trial test plan as described in Phase 2; 3) carry out a detailed evaluation and analysis of the oil fraction at each of two separate laboratories (the oil will be assessed qualitatively and quantitatively as a refinery feedstock for liquid fuel or chemical production); 4) assess the residual plant material in terms of yield, availability, potential value, and byproduct utilization as protein, fibre or liquid fuels; 5) carry out an initial selection of plant breeding stock based on the morphology of the plant and the wild colony of which it is a member; 6) collect seed from wild colonies to assist in further establishing replicated plots for possible future yield and agronomic studies and; 7) make preliminary suggestions of possible process flow configurations that might involve on farm cultivation, harvesting and extraction, industrial extraction and refinery, end-uses, marketing and future R&D requirements.

REPORTS

STATUS AND COMMENTS

The project is a continuation of a preliminary study on Showy Milkweed (Asclepias speciosa) that was carried out in 1980 by the Saskatchewan Research Council. The preliminary study cost was $34,000 and was funded equally by Federated Co-operatives Ltd. and CSP Foods.

PROJECT DATA

128

TITLE Preparation of Aquatic Feedstock

CONTRACT # 31155-9-2636 (ISC80-63)

ORGANIZATION C.B.C.L. Limited
P.O. Box 1269N
Halifax, Nova Scotia.

PRINCIPAL INVESTIGATOR

DURATION June 1980 - December 1981

COST $277,610

SPONSOR National Research Council

SCIENTIFIC AUTHORITY R.P. Overend
Division of Energy
N.R.C.
Bldg. M-50
Ottawa, Ontario. K1A 0R6
(613) 993-3405

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81 1981-82				$277,610

REPORTS

Energy From Aquatic Biomass - Interim Report, by CBCL Ltd., February 1981.

Energy from Aquatic Biomass - Final Report, by CBCL Ltd., October 1981.

OBJECTIVE

To develop an economical and environmentally acceptable process for converting aquatic weeds to a fuel source and to design the necessary equipment and process system for implementation, utilizing Eurasian water millfoil (Myriophyllium spicatum) as feedstock.

DESCRIPTION

1. Evaluate a process conceived in the United Kingdom by using laboratory scale model equipment.
2. Prepare a conceptual design for a complete system from harvesting to the production of the solid fuel source and include preliminary capital and operational cost analysis.
3. Assess the theoretical energy balances from millfoil feedstock from its chemical and biological composition.
4. Complete detailed designs for prototype equipment based on conceptual layouts.

STATUS AND COMMENTS

Complete.

ENVIRONMENTAL EFFECTS

PROJECT DATA

105

TITLE Effects of harvesting biomass for energy on the nutrient status and long term productivity of selected forest sites in the Maritimes

CONTRACT # 07SC.KL003-9-0020 (OSC79-00086) P40

ORGANIZATION Institute for Resources & Environmental Studies
Dalhousie University
Halifax, N.S.

PRINCIPAL INVESTIGATOR Dr. A. Hanson

DURATION May 1979 - March 1983

COST $165,093

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY Dr. M.K. Mahendrappa
Maritimes Forest Research Centre, C.F.S.
Box 4000,
Fredericton, N.B. E3B 5P7
(506) 452-3549

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1979-80	$34,435			$34,435
1980-81	$49,990			$49,990
1981-82	$49,990			$49,990
1982-83	$30,678			$30,678

REPORTS

"Effects of Harvesting Biomass for Energy on the Nutrient Status and Long-term Productivity of Selected Forest Sites in the Maritimes - Annual Report", 1979-80, M.K. Mahendrappa, Dalhousie University.
(Available from ENFOR Secretariat.)

OBJECTIVE

To determine the contents of major nutrient elements in the tree layer (by tree components), shrub layer, surface organic layer, and upper mineral soil on a series of sites of different inherent fertility levels, occupied by stands of different species composition and stages of development. To determine the quantities of nutrients which are being added to, circulated within, and removed in the form of biomass from the ecosystem at each selected site. To evaluate the effects on the nutrient cycle and long-term maintenance of productivity of biomass removal for energy purposes.

DESCRIPTION

The study will take four years to complete and should provide essential, quantitative information on the nutrient effects of biomass removal. It will also permit the identification of those sites incapable of supporting biomass removal without significant loss of fertility and productivity. The work will be carried out in Nova Scotia because a large proportion of the forest sites in that Province are of low fertility.

Two areas, each having relatively uniform geology and well-drained soils but of different levels of inherent fertility (one markedly nutrient deficient, corresponding to C.L.I. class 6; the other of average or slightly above average fertility, corresponding to C.L.I. class 4/5) will be selected in western or central Nova Scotia, probably in the Anna-King Crown Land Block. In each area twenty-five .04 ha plots will be laid out - five under each of the following cover types: mature softwoods, young (pole stage) softwoods, mature hardwoods, young hardwoods, recent (1978 and/or 1979) whole-tree harvested cutovers.

STATUS AND COMMENTS

Various sites as outlined above were selected and characterised in terms of tree heights and dbh, and by describing soil profiles. Bulk rain samplers were set up in recently clearcut open areas. Ground vegetation and soil were sampled from these open areas. Two 0.5-ha blocks in a mature softwood stand were harvested to estimate (one under the conventional and the other under whole tree harvesting conditions), the biomass and nutrients removed from the sites under different harvesting methods. In all these sites, five 0.04 ha plots were laid out for further study.

4.3.2.1 Environmental Effects/Forestry - Silvicultural and Harvest Impacts. 31/3/82

PROJECT DATA 107

TITLE Nitrogen-fixing & Mycorrhizal Symbioses in Forests to Increase Biomass Production & Maintain Soil Fertility

CONTRACT # KL011-9-0007(OS079-47) P78, P198

ORGANIZATION Faculté de Foresterie
Université de Laval
Ste-Foy, Quebec. G1K 7P4

PRINCIPAL INVESTIGATOR André Fortin (418) 656-2384

DURATION April 1979 - March 1983

COST $346,100

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY Dr. G. Prisque
Laurentian Forest Research Centre
P.O. Box 3800
1080 Route du Vallon
Ste. Foy, Québec
G1V 4C7

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR	IN-HOUSE	TOTAL
1979-80	$ 39,814			$ 39,814
1980-81	$ 54,486			$ 54,486
1981-82	$116,840		$1,500	$118,340
1982-83	$132,200			$132,200

OBJECTIVE

To find ways of increasing productivity and maintaining soil fertility of intensive forestry systems grown to produce biomass using nitrogen-fixing species to reduce dependence on ferilizers that are costly in terms of dollars and energy.

DESCRIPTION

1. Prepare a report summarizing available information of N-fixation in forests, its potential as a management tool to increase yeild of biomass and maintain soil fertility and need for further research.
2. Establish experiments to examine effects of N-fixing symbioses on yield and soil fertility and, to study the mechanisms involved.
3. Select superior N-fixing genotypes.
4. Examine nitrogen pathway.
5. Attempt to control and produce the Alder endophyte (Frankia).
6. Search for mycorrhizae common to Alder and other tree species to facilitate nitrogen transfer from one species to another.

REPORTS

Uses of Nitrogen Fixation and Other Root Symbioses for Biomass Production by J. Andre Fortin, Université Laval. (Interim Report, May 1981). ENFOR Project P-78. (Available from ENFOR Secretariat and Energy Library)

STATUS AND COMMENTS

Related completed work is described on project sheet 16 in Concluded Projects Section.

Sites selected, plants raised for planting in 1980. Nitrogen pathway and screening experiment in progress. Common mycorrhizae (Alnus and Picea) located (Paxillus). Frankia production under control.

Interim report dated May 1981 covers work performed to July 1980 but does not attempt to synthesize the research results. Such will be the content of subsequent reports. (B. Summers, June 1981.)

PROJECT DATA

164

TITLE Reforestation of Areas Harvested for Biomass

CONTRACT # KL001-9-113 (OSC80-45) P145

ORGANIZATION Abitibi-Price (Nfld) Pulp & Paper Ltd
P.O. Box 6028
Grand Falls, Newfoundland
A1C 5X8

PRINCIPAL INVESTIGATOR

DURATION April 1980 - March 1982

COST $18,970

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY J. Richardson
Newfoundland Forest Research Centre
CFS
Building 304, Pleasantville
St. John's, Newfoundland
A1C 5X8

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$12,900			$12,900
1981-82	$ 6,070			$ 6,070

OBJECTIVE

To conduct post-treatment ecological measurements and observations on the experiment plots, to determine the effects of hardwood eradication treatments on site and vegetation, and to determine the success to date of the softwood regeneration treatments.

DESCRIPTION

The experiment is in two parts, one involving the establishment of 6 hybrid poplar clones (the 'Poplar study'), the other involving a variety of regeneration treatments (the 'Reforestation study'). Both studies have similar split-split-plot arrangements of treatments in a randomized complete-block design. The Poplar study has 6 replications, the Reforestation study has 3.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

224

TITLE Impact of forest biomass production on reptiles and amphibians in the Great Lakes - St. Lawrence Forest Region

CONTRACT # KM107-1-4316 (OSC81-00002) P-226

ORGANIZATION The Environmental Applications Group Ltd.
114 Avenue Road
Toronto, Ontario
M5R 2H4

PRINCIPAL INVESTIGATOR D.A. Sims

DURATION October 1981 - March 1983

COST $38,795

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY Dr. E.S. Telfer
Canadian Wildlife Service
Western and Northern Region
Environment Canada
1000-9942 108th Street
Edmonton, Alberta
T5K 2J5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$20,000			$20,000
1982-83	$18,795			$18,795

REPORTS

OBJECTIVE

The project is designed to evaluate the impact on reptiles and amphibians of management of forest lands for maximum production of biomass in the Great Lakes - St. Lawrence Forest Region in Central and Eastern Ontario and Southern Québec

DESCRIPTION

The project studies will involve:

a) Preparation of an annotated bibliography of the world literature relating to the impact of forest management practices on reptiles and amphibians.

b) Prediction of management practices likely to be employed in biomass production in the area of the study with potential proportions of the area suitable for such practices.

c) Field study to establish preferred habitat conditions for reptile and amphibian species in the area with special attention to rare or vulnerable forms.

d) Field measurement to provide quantitative data on habitat parameters.

e) Analyses of quantitative habitat descriptions to estimate gains or losses in habitat for various species likely to result from biomass production.

f) Recommendations regarding suitable mitigation procedures where advisable to safeguard forms rare in Ontario or Québec.

STATUS AND COMMENTS

4.3.2.1 Environmental Effects/Forestry - Silvicultural and Harvest Impacts. 21/3/82

PROJECT DATA

159

TITLE Evaluation of Reforming as a Practical Technique for the Elimination of water pollution from wood gasifiers

CONTRACT # KL229-0-4119 (OSS80-46) C166

ORGANIZATION 445872 Ontario Incorporated
65 Pringle Avenue
Markham, Ontario
L3P 2P5

PRINCIPAL INVESTIGATOR John Black

DURATION April 1980 - March 1982

COST $133,005

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Vincent Massey Building
Hull, Québec K1A 0E7
(613) 997-1682

TECHNICAL LIAISON OFFICER: Bob Graham
Forintek Canada Corporation
800 Montreal Road
Ottawa, Ontario K1G 3Z5
(613) 744-0963

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$55,244			$55,244
1981-82	$77,760			$77,760

REPORTS

OBJECTIVE

a) To define the thermodynamic limitations of reforming tars from wood gasifiers.

b) To evaluate reforming as a practical technique for reducing water pollution from wood gasifiers

c) To test a model reformer under operating conditions.

DESCRIPTION

A technique for the gaseous destruction of tars will result in minimal costs for water treatment and avoid environmental concerns about the dissipation of potentially carcinogenic compounds into the environment.

A list of the identified components in wood tars will be assembled from previous studies. These compounds will be evaluated thermodynamically to determine which of them can be destroyed by catalytic steam reforming. Engineering designs of processes for reforming of the tars will be reviewed to determine the most effective means of tar destruction. Treatment cost will be established for a few chosen routes. A test facility will be assembled and evaluated at one of more gasifier sites by extracting and analysing the condensibles.

STATUS AND COMMENTS

INTERNATIONAL PARTICIPATION

INTERNATIONAL PARTICIPATION

Forestry Energy

Canada, via the Department of Fisheries and the Environment, signed the Forestry Energy Implementing Agreement of the International Energy Agency (IEA) in April 1978 in Tokyo. The objective of the agreement is to increase the co-operation among the present ten signatory countries on programs and projects in the field of Forestry Energy. Forestry Energy is defined as the use of short-rotation forestry biomass and forestry residues to produce clean fuels, petro-chemical substitutes and other energy-intensive products.

To date the signatories have concentrated on the one task of developing a program of voluntary co-operation and co-ordination in the planning and execution of national programs. To achieve this objective four groups were established to work on systems analysis, growth and production, harvesting and transportation, and conversion.

Since April 1978, nine meetings of the executive committee have been held, two of them in Canada. In 1981 C.R. Silversides, National Research Council, Ottawa, was elected chairman of the executive committee following the resignation of Mr. Lars Rey, Sweden. The Canadian representative on the executive committee is W. Fullerton, Director-General, Forestry Relations and Renewal Directorate, Canadian Forestry Serice. Barbara Summers, National Research Council, Program Manager, Bioenergy, is his alternate.

The most active groups under this agreement are those dealing with growth and production, and harvesting and transportation. Dr. Louis Zsuffa, Senior Scientist, Ontario Tree Improvement and Forest Biomass Institute, Maple, Ontario, heads the growth and production group. This group met twice in 1981, once in Toronto and then in Kyoto, Japan, followed by an excursion to south Korea. In 1981 twenty joint actions were undertaken of which six were completed with reports issued. This group has now identified the core issues of biomass production and has initiated research, development and demonstration projects to solve these.

Dr. Louis Zsuffa maintains liaison with the International Poplar Commission (IPC) of the Food and Agricultural Organization of the United Nations (FAO). He has also initiated co-operation with the Internatinal Union of Forestry Research Organizations (IUFRO), experts on Poplar breeding and Poplar provenances.

A major event in Canada in 1981 was the formation of the Ontario Tree Improvement and Forest Biomass Institute at Maple, Ontario, by the Ministry of Natural Resources. This was in large degree the result of activities of the Planning Group on Growth and Production and is expected to have a major impact in Canada on work dealing with forest biomass for energy.

The group working on harvesting, on-site processing and transportation is chaired by Prof. P.O. Nilsson, College of Forestry, Swedish University of Agricultural Sciences, Garpenberg, Sweden. This group had four meetings in 1981 and has a very active program of research, development and demonstration in which Canada is playing an active role. The Forest Engineering Research Institute of Canada has been delegated the role of Canada's agent in heading two important projects: 1) the preparation or comminution of forest biomass with respect to harvesting, transportation, drying and storing for optimal conversion by whatever process; and 2) harvesting and transport of logging residuals and residues, including stumps. These two topics play a large part in Canada's national program on the use of forest biomass for energy.

Canada's representative on the planning group dealing with harvesting and transport is T. Golob, Bioenergy Program, National Research Council, Ottawa.

The group identified as dealing with systems analysis is being restructured and it's activities will be incorporated into the work of the other groups.

Conversion of biomass as a subject for international co-operation has been low key and slow to get underway. However a project dealing with the planning, design, construction and trial operation of a biomass liquefaction test facility has been agreed to by three countries and is underway. The same group is holding an international symposium on thermo-chemical conversion of biomass in October 1982 in the United States.

BIOMASS TECHNICAL INFORMATION SERVICE

On 24 May 1978 the International Energy Agency established an implementing agreement to provide a Biomass Technical Information Service to participating countries. The National Research Council, on Canada's behalf, joined this service in May 1979. Other members of the service are Austria, Belgium, Commission of the European Community, Federal Republic of Germany, Ireland, Italy, New Zealand, Sweden, Switzerland, the United Kingdom, and the United States. Canada's member on the Executive Committee is Mrs. Marianne J. Hurley, head of Branch Facilities, Canada Institute for Scientific and Technical Information.

The Operating Agent is the Government of Ireland acting through the National Board for Science and Technology.

The function of the Service is to provide the participants with a regular source of information on Scientific and technical data in all areas of Energy from Biomass, including production, harvesting, collection, processing, transportation and conversion techniques. The presentation of this information is in the form of:

- Abstract Bulletins
- Literature reviews and researches on selected topics
- Referral service for documentation, data and research activities
- Co-ordination with other information services

It is intended that the Service should be an interactive aid to the R&D community, by establishing a network of direct communication for researchers and R&D managers in this rapidly expanding area.

Biomass Abstracts

Biomass abstracts cover the literature on all aspects of the production of energy from biomass and are available on subscription from:

International Energy Agency
Biomass Technical Information Service
Institute for Industrial Research and Standards
Ballymun Road
Dublin 9
Ireland

The cost is £(IR) 42 per year.

For further information on the service, contact:

Head, Energy Division
National Board for Science and Technology
Shelbourne House
Shelbourne Road
Dublin 4, Ireland

Tele: Dublin 683311
Telex: 30327 NBST EL

The biomass abstracts contain information on:

ANIMAL WASTES - Fuel Generation
- Premium Biomass Usage

CROP RESIDUES - Fuel Generation
- Premium Biomass Usage

DOMESTIC - General Utilization
URBAN WASTES - Fuel Generation
- Named Systems

FORESTRY - Short Rotation Forestry
PRODUCTS - Forest Residues
- Cellulose Utilization

Retrospective Bibliographies

Retrospective Bibliographies cover specific topics, and are individually priced. Available to date are:

Short-Rotation Forestry, March 1977	$ 4.50
Short-Rotation Forestry, Feb. 1978	$ 2.00
Short-Rotation Forestry, Update - Feb. 1979	$ 2.00
Combustion and Pyrolysis of Wood and Wood Wastes, July 1977	$ 4.50
Harvesting of Biomass, Nov. 1977	$ 4.50
Liquefaction of Biomass, June 1979	$ 9.00
Biochemical Production of Alcohol Fuels July 1979	$ 9.00
Harvesting of Forest Residues, August 1979	$ 9.00
Thermochemical Production of Alcohol Fuels March 1980	$ 4.50
Energy Systems Analysis, April 1980	$ 4.50
Wood & Wood Residues and Source of Chemicals June 1980	$ 9.00
Wood & Wood Waste Burning Equipment, Sept. 1980	$ 4.50

In Production:

Environmental Aspects of Biomass Systems
Materials Handling & Storage of Biomass
Non-Forest Energy Crops
Biomass Densification
Inventory of National & International Biomass
R&D Research Programs Vol. I
Vol. II

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HARVESTING AND COLLECTION

PROJECT DATA

76

TITLE: Development of the PALLARI Brush Harvester

CONTRACT #: P27/SP10 (P223 as of 1981-82)

ORGANIZATION:

PRINCIPAL INVESTIGATOR:

DURATION: July 1979 - March 31, 1982

COST: $158,000

SPONSOR: Environment Canada

SCIENTIFIC AUTHORITY: L.F. Riley
Great Lakes Forest Research Centre
Canadian Forestry Service
Sault Ste. Marie, Ontario.
(705) 949-9461

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1979-80	$ 5,500			$ 5,500
1980-81	$97,500			$97,500
1981-82	$55,000			$55,000

REPORTS

No reports available because of the limited progress to date.

OBJECTIVE

To develop and test brush harvesting equipment.

DESCRIPTION

Large areas of insufficiently restocked forest lands in Canada are now occupied by dense alder, birch and other brush species. The brush on such areas represents substantial quantities of useable biomass as well as a formidable obstacle to reforestation to more valuable species. By effectively harvesting such brush, benefits would accrue in the form of biomass for conversion to energy, and the opportunity to reforest the brush-cleared lands.

In February 1979 a contract, 9SSS.KL012-8-0205 (OSS78-00389), was entered into with Hyd-Mech Engineering, Box 1030, Woodstock, Ontario, N4S 8A4, to prepare the engineering drawings for a potential alternative to the Pallari brush harvester.

After evaluation of the Hyd-Mech and other designs it was decided the best opportunity for harvesting such brush was through the further development and application of the Pallari Harvester, a machine developed in Finland. This machine is designed for use on wild-lands, and differs substantially from harvesters designed for use in mini-rotation energy forests.

It has been proposed that forest energy program funds be used to finance the further testing of the Pallari Harvester in Canada.

The Great Lakes Forest Research Centre at Sault Ste. Marie, Ontario will be responsible for negotiation with appropriate Finnish authorities for licensing arrangements and for Canadian fabrication and testing contracts.

STATUS AND COMMENTS

- Contract KL012-8-0205 with Hyd-Mech Engineering is complete.
- Negotiations underway with manufacturer to construct a test unit.
- Proposal to test a Swedish unit in Canada has been submitted by Great Lakes Forest Research Centre.
- Because of technical delays in machine development in Scandanavia, the project is under re-evaluation. The project has been extended to March 1982.

PROJECT DATA

195

TITLE Development of the RECUFOR and application of the RECUFOR rotor to comminution of residues at landings

CONTRACT # KL229-1-4203 (OSS81-00095) P-210/P-215

ORGANIZATION Forest Engineering Research Institute of Canada
143 Place Frontenac
Pointe Claire, Québec
H9R 4Z7

PRINCIPAL INVESTIGATOR Denis Brière

DURATION July 1981 - March 1982

COST $522,121

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY C.R. Silversides
Bioenergy Program
Division of Energy Research and Development
National Research Council
Room 381, Building M-55
Ottawa, Ontario
K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$552,121			$552,121

OBJECTIVE

1. The development of the RECUFOR.
2. Applications of the RECUFOR rotor to the comminution of residues at landings. The RECUFOR concept consists essentially of a powered, 3-foot diameter, cylinder equipped with 3 rows of curved teeth whose main function is to pick up on-the-ground logging residues. These residues are sheared against fixed knives. the purpose of the contract is: (a) to design, fabricate and test a mobile machine incorporating the RECUFOR concept; (b) to augment the comminution process by combining the RECUFOR with a conventional hog or chipper, to prepare the best material for storage, transportation and conversion.

DESCRIPTION

A.

1. To assess the various possible conceptual configurations for the RECUFOR and to select one for development.
2. To develop the design selected under (1) in sufficient detail that it can be efficiently manufactured and to prepare all necessary shop drawings and/or specifications for all components.
3. To manufacture one model of the machine according to the drawings and specifications of (2) above.
4. To execute shop and critical field tests with the machine of (3) above to ensure that it is free of major faults and to correct any such faults.

B.

1. The development of a design combining the RECUFOR with a conventional comminution device. A technical and economic feasibility analysis to be included.
2. Based on the design developed in (B.1), a program is to be proposed for the development and testing of an experimental prototype incorporting the RECUFOR.

REPORTS

STATUS AND COMMENTS

Sub-contract to Logging Development Corp. of Pointe Claire, Québec.

PROJECT DATA 219

TITLE Feasibility study and design concepts to modify "HODAG" tree planter

CONTRACT # 31155-1-2674-A (OSX81-00120)

ORGANIZATION Timberland Equipment Limited
P.O. Box 490
Industrial Avenue
Woodstock, Ontario
N4S 7Z2

PRINCIPAL INVESTIGATOR Mr. Anthony Paladino
(519) 537-6262

DURATION January 1, 1982 - March 31, 1982

COST $23,600

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Theodore B. Golob
Bioenergy Program
Energy Research and Development
National Research Council
Room 381, Building M-55
K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$23,600			$23,600

REPORTS

OBJECTIVE

1. To study the feasibility of modifying the "HODAG" tree planter so that it can plant poplar cuttings automatically.

2. To provide one or more design concept proposals for the modified planter.

DESCRIPTION

The design of the hybrid poplar planting machine will be determined by the design of the existing planting device "HODAG" developed by the contractor, and by a set of given biological, technical and economic constraints. Because of the nature of farm operations and a relatively short planting period, the productivity of the machine must be optimized. The initial design should be for a two row planter of a modular design, with a capability of varying the number of planting heads. It can be either an independent piece of equipment pulled by a farm tractor or an attachment for a tractor. Feeding of poplar cuttings into the planting head should be automatic, and the size of the magazine for the cuttings should be as large as practical; also, the ground speed should be as high as it is practically and economically feasible.

STATUS AND COMMENTS

PROJECT DATA

220

TITLE Harvester - Buncher Feasibility Study and Design Concepts

CONTRACT # 31155-1-2674-G (OSX81 - 00129)

ORGANIZATION Hyd-Mech. Engineering Ltd.
39 Houser's Lane
P.O. Box 1030
Woodstock, Ontario
N4S 8A4

PRINCIPAL INVESTIGATOR S.K. Jasinski

DURATION January 1982 - March 31, 1982

COST $29,491.46

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Theodore B. Golob
Bioenergy Program
Division of Energy Research and Development
National Research Council
Room 382, Building M-55
Ottawa, Ontario K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$29,491.46			$29,491.46

OBJECTIVE

To conduct feasibility study and provide design concepts for the following hybrid poplar harvesting systems:

1. Felling - Prebunching - Skidding
2. Felling - Bunching - Forwarding by trailer
3. Felling - Bunching - Forwarding by harvester

DESCRIPTION

The design of the harvester will be determined by a set of given constraints, by the choice of the cutting tool and by the system.

The desired operating ground speed is 2.4 km/h; the capacity of the cutting tool must match the ground speed of the harvester; the bunching capability must also match the ground operating speed of the machine.

Because of the nature of agricultural operations the harvesting devices should preferably be attachments to a small commercially available agricultural tractor.

The study should involve analysis of operational systems supporting the proposed design concepts and should be based on the economic and operational requirements.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

221

TITLE: Grapple Skidder Attachment - feasibility study and design concepts

CONTRACT #: 31155-1-2674-H (OSX81-00125)

ORGANIZATION: Do-Tan Tool & Gauge Manufacturing Ltd.
15 Hatt Street
Dundas, Ontario
L9H 2G1

PRINCIPAL INVESTIGATOR: R.G. Elms

DURATION: January 1982 - March 31, 1982

COST: $4,887.50

SPONSOR: National Research Council

SCIENTIFIC AUTHORITY: Theodore B. Golob
Bioenergy Program
Division of Energy Research and Development
National Research Council
Room 382, Building M-55
Ottawa, Ontario K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$4,887.50			$4,887.50

OBJECTIVE

To conduct feasibility study and provide design concepts for the Grapple Skidding Attachment installed on the three-point hitch of a Holder A60 tractor.

DESCRIPTION

The study should analyse the capacity of the three-point hitch mounting arrangement of the Holder A60 tractor and provide calculations for the limiting dynamic requirements.

The Grapple design concepts should be based on operational and economic constraints, also on ease of handling and skidding prebunched hybrid poplar trees. The design should also provide for a simple and effortless installation and removal of the attachment.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

222

TITLE Study and analysis of harvesting systems

CONTRACT # 31155-1-2674-M (OSX81-0019)

ORGANIZATION David Spanjer & Associates
37 Elliotwood Court
Willowdale, Ontario
M2L 2P8

PRINCIPAL INVESTIGATOR David L. Spanjer

DURATION January 1982 - March 31, 1982

COST $15,500

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Theodore B. Golob
Bioenergy Program
Division of Energy Research and Development
National Research Council
Room 382, Building M-55
Ottawa, Ontario K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$15,500			$15,500

OBJECTIVE

To study and evaluate harvesting systems for hybrid poplar plantations leading to the recommendation for the most suitable system or systems.

DESCRIPTION

The study should involve analysis of all operational systems supporting the proposed system concepts and should be based on the economic and operational requirements. The analysis will include such factors as:

- output per production module
- capital cost per production module
- labour requirements per production module
- production/person day per production module
- cost/kg of poplar (plantation site)
- cost/kg of poplar (conversion site)
- description of basis of system analysis (labour rate, depreciation method, fuel cost, methods of estimating manufacturing and selling costs for key new machines)
- comparison of results obtained above with known operations such as pulpwood and sugar cane harvesting
- total development cost (including engineering, tooling, prototypes, production machines, testing)

REPORTS

STATUS AND COMMENTS

PROJECT DATA

226

TITLE Mobile Roadside Chipper - Feasibility Study and Design Concept

CONTRACT # 31155-1-2674 L (OSX81-00117)

ORGANIZATION University of New Brunswick
P.O. Box 4400
Fredricton, N.B.
E3B 5A3

PRINCIPAL INVESTIGATOR Prof. C.A. Short
(506) 453-4506

DURATION January 1982 - March 31, 1982

COST $10,836

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Theodore B. Golob
Bioenergy Program
Division of Energy Research and Development
National Research Council
Room 381, Building M-55
Ottawa, Ontario
K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$10,836			$10,836

OBJECTIVE

1. To study power requirements for a roadside chipper as a component of a harvesting system for hybrid poplar plantations.

2. To provide one or more design concept proposals for the mobile roadside chipping system.

DESCRIPTION

The composition and design of the roadside chipping system will be evaluated as a part of the overall harvesting system. The productive capacity of the chipper will be determined by a projected productivity of the plantation harvesting system, power plant size and the economic constraints of typical farm operations.

The chipper loading equipment will be a part of the system and will be chosen on the basis of a balanced operation.

The chipping operation will be designed as an integral part of the system within the productive capacity of the field and road transportation equipment.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

227

TITLE Insertion Planter - Feasibility Study and Design Concepts.

CONTRACT # 31155-1-2674-C (OSX81-00142)

ORGANIZATION Logging Development Corporation
5858 Côte de Neiges Road
Suite 215
Montreal, Québec
H3S 1Z1

PRINCIPAL INVESTIGATOR D.D. Hamilton
(514) 739-1791

DURATION January 1982 - March 31, 1982

COST $15,050

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Theodore B. Golob
Bioenergy Program
Division of Energy Research and Development
National Research Council
Room 381, Building M-55
Ottawa, Ontario
K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$15,050			$15,050

OBJECTIVE

To study the feasibility and provide design concepts for an automatic insertion planter.

DESCRIPTION

The sutdy and design concepts will provide the information for a possible development of an automatic planting machine capable of inserting Hyrid Poplar cuttings into the ground. The design of the planting machine will be determined by operational and economic constraints and by the nature of the planting action. The initial design should be for a two row planter of a modular design, with a capability of varying the number of planting heads. Preferably, the planting equipment should be designed as an attachment to a small farm tractor of no more than 70 P.T.O. HP. The planting is done over a very soft terrain requiring a low ground pressure.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

228

TITLE Control of Tree Cutting Height and Planting Depth - Feasibility Study and Design Concepts

CONTRACT # 31155-1-2674-M (OSX81-00118)

ORGANIZATION University of Saskatchewan
Division of Control Engineering
Saskatoon, Saskatchewan
S7N 0W0

PRINCIPAL INVESTIGATOR Prof. J.N. Wilson
(306) 343-3149

DURATION January 1982 - March 31, 1982

COST $21,925

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Theodore B. Golob
Bioenergy Program
Division of Energy Research and Development
National Research Council
Room 381, Building M-55
Ottawa, Ontario
K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$21,925			$21,925

OBJECTIVE

To study requirements and provide design concepts for control of the height of harvesting and depth of planting of hybrid poplar plantations.

DESCRIPTION

The study will be based on the evaluation of the existing and proposed poplar plantation equipment. Various height and depth technics will be considered for all planting and harvesting equipment under study. Such technics as optical, ultrasonic and mechanical sensing will be analysed in conjunction with individual equipment requirements; the most suitable techniques for control of tree planting and harvesting equipment will be chosen for further analysis.

Several control design concepts and operational control strategies will be developed for an eventual implementation of the control system hardware to planting and harvesting equipment.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

229

TITLE Tree Harvester/Chipper - Feasibility Study and Design Concepts

CONTRACT # 31155-1-2674-F (OSX81-00139)

ORGANIZATION Nicholson Murdie Machines Ltd.
327 Harbour Road
Victoria , B.C.
V9A 3S2

PRINCIPAL INVESTIGATOR Thomas E. Savage
(206) 682-2752

DURATION January 1982 - March 31, 1982

COST $38,050

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Theodore B. Golob
Bioenergy Program
Division of Energy Research and Development
National Research Council
Room 381, Building M-55
Ottawa, Ontario
K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$38,050			$38,050

OBJECTIVE

To conduct feasibility study and provide design concepts for a tree harvester/chipper.

DESCRIPTION

The feasibility study should evaluate design constraints in view of all economic and operational requirements. The productivity and vehicle ground speed are subject to the cost, size and weight of the chipping unit. Harvesting and chipping devices should be designed as attachments for a small farm tractor of not more then 70 P.T.O. HP.

The design sutdy will include:

- Power requirements
- Power transmission systems
- Chipping head description
- Tree felling tool description
- Chip discharge arrangement
- Machine productivity and capacity

REPORTS

STATUS AND COMMENTS

PROJECT DATA

230

TITLE Reciprocating Tree Cutting Tool - Feasibility Study and Design Concepts

CONTRACT # 31155-1-2674-K (OSX81-00144)

ORGANIZATION J.D. Reed Machine Limited
53 Empey Street
P.O. Box 188
Brantford, Ontario
N3T 5M8

PRINCIPAL INVESTIGATOR A. Maiste
(519) 753-3909

DURATION January 1982 - March 31, 1982

COST $14,400

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Theodore B. Golob
Bioenergy Program
Division of Energy Research and Development
National Research Council
Room 381, Building M-55
Ottawa, Ontario
K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$14,400			$14,400

OBJECTIVE

1. To study the feasibility of felling trees by means of a reciprocating device.
2. To provide design concepts for such a reciprocating tree cutting tool.

DESCRIPTION

Feasibility study and design concepts for a high velocity reciprocating tree cutting tool for five-year old hybrid poplar plantations. The device should be designed to cut one row of trees at a ground speed of approximately 2.5 km/h and should be capable of withstanding the impact on contact with the tree. The study should evaluate knives against a modified saw blade. The width of cut is assumed to be 35 cm.

The cutting device would become a part of a tree harvester attachment for a small agricultural tractor of not more than 70 P.T.O. HP.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

231

TITLE: Design Study - Operator's Environment and Controls

CONTRACT #: 31155-1-2674-Q (OSX81-00133)

ORGANIZATION: School of Industrial Design
Carleton University
Ottawa, Ontario
K1S 5B6

PRINCIPAL INVESTIGATOR: Prof. W. Gilles
(613) 231-3858

DURATION: January 1982 - March 31, 1982

COST: $13,386

SPONSOR: National Research Council

SCIENTIFIC AUTHORITY: Theodore B. Golob
Bioenergy Program
Division of Energy Research and Development
National Research Council
Room 381, Building M-55
Ottawa, Ontario
K1A OR6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$13,386			$13,386

OBJECTIVE

1. To provide design concepts for operator's controls and environment for harvesting, planting and transportation equipment.
2. To consult and guide other contractors involved in the design of harvesting, planting and transportation equipment.
3. To provide visual information material on the individual equipment designs and on the overall harvesting and planting systems.

DESCRIPTION

An analysis of the vehicle's operator-machine interface will be made in view of the human factors aspects. The study will consider design requirements for conversion of the carrier vehicles as related to the envisaged operational tasks.

As a result of analytical studies, design ideas and concepts will be formulated for additional controls in the existing operator's environment. Also, design ideas and concepts for balanced designs of attachements, equipment and systems will be generated and communicated to contractors involved in the design of poplar plantation production systems.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

233

TITLE Soil Strength Measurements - Evaluation Study

CONTRACT # 31155-1-2674-D (OSX81-00132)

ORGANIZATION Carleton University
Faculty of Graduate Studies & Research
Ottawa, Ontario K1S 5B6

PRINCIPAL INVESTIGATOR Dr. J.Y Wong
(613) 231-4317

DURATION January - April 30, 1982

COST $23,280

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Theodore B. Colob
Bioenergy Program
Division of Energy Research and Development
National Research Council
Room 381, Building M-55
Ottawa, Ontario
K1A OR6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$23,280			$23,280

OBJECTIVE

To provide terrain strength parameters needed for the design and development of appropriate terrain - vehicle systems for planting and harvesting hybrid poplar plantations in Eastern Ontario.

DESCRIPTION

Terrain measurements will be made at two typical plantation sites in an area between Cornwall and Prescott, Ontario. The soil strength measurements will be made using a vehicle mounted Bevameter and will include:

a) pressure-sinkage relations;
b) shear strength;
c) moisture content;
d) grain size distribution of soils;
e) bulk density of the terrain.

The terrain data will be collected under three different soil moisture conditions. The results of the pressure - sinkage and shearing tests will be analyzed and evaluated using the computerized procedures developed by the Transport Technology Research Laboratory of Carleton University.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

243

TITLE Optimization of Terrain-Vehicle Systems in Agro-Forestry

CONTRACT # 31155-1-2674-E (OSX81-00161)

ORGANIZATION Dr. M.G. Bekker
224 East Islay Street
Santa Barbara, Ca. 93101
U.S.A.

PRINCIPAL INVESTIGATOR Dr. M.G. Bekker
(805) 966-3486

DURATION February 12, 1982 - June 30, 1982

COST $25,216

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Theodore B. Golob
National Research Council
800 Montreal Road
Room 381, Building M-55
Ottawa, Ontario
K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$14,326			$14,326
1982-83	$10,890			$10,890

OBJECTIVE

1. To outline the method of terrain-vehicle system evaluation, procedures and their validation.
2. To recommend optimized terrain-vehicle systems for two typical hybrid poplar plantation sites in Eastern Ontario.

DESCRIPTION

Phase I The scope of the study will pertain to a complete and general outline of the methodology considering:

1. Definition of parameters for measurements of soil properties and terrain surface, from locomotion viewpoint;
2. Description and referencing to instrumentation for soil measurements, developed in various countries;
3. Mathematical models of soil-vehicle relationship and semi-empirical algorythms for vehicle design-performance evaluation;
4. Validation of the above semi-theoretical approach through computations of several examples and case studies, including comparison of the results with experiments made with various sizes and types of tires;
5. Vehicle mobility optimization as outlined in the procedural charts and diagrams with the definition of environment and mission requirements, based on engineering practice.

Phase II Soil-vehicle systems will be evaluated for two typical plantation soils at four different moisture contents and three vehicles with two variants of tires. The evaluations will include computation and optimization of the following parameters:

1. Drawbar pull-slip
2. Slope climbing
3. Rudimentary power estimates
4. Rudimentary fuel consumption estimate
5. Vehicle envelope and weight

REPORTS

STATUS AND COMMENTS

4.3.5 Biomass Planting, Harvesting and Collection Technologies.

23/3/82

PROJECT DATA

244

TITLE: Feasibility Study and Design Concepts for a Rear End Piler Attachment

CONTRACT #: 31155-1-2674-T (OSX81-00163)

ORGANIZATION: Do-Tan Tool & Gauge Manufacturing Ltd.
15 Hatt Street
Dundas, Ontario
L9H 2G1

PRINCIPAL INVESTIGATOR: R.G. Elms
(416) 628-2241

DURATION: February 12, 1982 - March 31, 1982

COST: $5,570

SPONSOR: National Research Council

SCIENTIFIC AUTHORITY: Theodore B. Golob
National Research Council
Montreal Road
Room 381, Building M-55
Ottawa, Ontario
K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$5,570			$5,570

OBJECTIVE

To conduct feasibility study and provide design concepts for a three-point hitch-mounted rear end piler attachment for Holder A60 tractor.

DESCRIPTION

The study will analyse the suitability of a three point hitch mounting arrangement to carry a typical rear end piler attachment for Holder A60 tractor.

The piler design concept should be based on operational and economic constraints, and on ease of scooping, handling and piling 5 year old hybrid poplar trees. It should also provide a capability of loading bunches of trees on a trailer. The design must insure a simple and effortless installation and removal of the attachment.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

254

TITLE The Design and Development of a Bundling Attachment for Poplar Harvester

CONTRACT # KL012-1-0084 OSS81-00121 P-201

ORGANIZATION Hovey & Associates Ltd.
2378 Holly Lane
Ottawa, Ontario
K1V 7P1

PRINCIPAL INVESTIGATOR

DURATION September 1981 - March 1982

COST $19,796

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY B.J. Sutherland
Great Lakes Forest
Research Centre
1189 Queen Street
Sault-Ste-Maire, Ontario

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$19,796			$19,796

OBJECTIVE

To design and build a bundling attachment for a poplar harvester.

DESCRIPTION

1. The uppermost tie will be approximately 90 to 122 cm higher than the first tie and provision made to make it adjustable within that range (90 to 122 cm) to accommodate varying heights of whip material.

2. The device must be designed and built to withstand the vibration and shock loading associated with mobile off-road service.

3. In addition to the sketch designs suitable for prototype manufacture, detailed engineering drawings to enable possible future fabrication are to be provided upon or prior to project completion. These drawings must indicate how the bundling device is to be built into the harvester and any modification required to the harvester, if applicable.

4. The present production rate of the harvester is not to be affected.

5. The Contractor will undertake, within this contract any adjustments or modifications subsequent to field testing near Kemptville, Ontario, under the supervision of the Scientific Authority or his representative.

REPORTS

STATUS AND COMMENTS

4.3.5 Biomass Planting, Harvesting and Collection Technologies. 22/3/82

CONVERSION TECHNOLOGIES

PROJECT DATA

20

TITLE Development, operation and demonstration of a farm scale anaerobic digester for production of methane from hog manure.

CONTRACT # 07SZ.01843-7-0752 (0SZ77-0152)

ORGANIZATION John Fallis, RR#3, Millbrook, Ontario L0A 1G0

PRINCIPAL INVESTIGATOR John Fallis (705) 932-5568

DURATION October 5, 1977 - November 31, 1983

COST $62,190

SPONSOR Agriculture Canada, Ottawa, Ontario.

SCIENTIFIC AUTHORITY Mr. R. Hocking
Engineering & Statistical Research Institute,
Research Branch
Agriculture Canada, Bldg. 94
Ottawa, Ontario.
(613) 995-9671

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1977-78	$16,384			$16,384
1978-79	$ 8,976			$ 8,976
1979-80	$ 4,000			$ 4,000
1980-81	$ 4,000			$ 4,000
1981-82	$16,000			$16,000
1982-83	$12,830			$12,830

OBJECTIVE

To develop and operate a farm scale anaerobic digester for production of methane from hog manure.

DESCRIPTION

1. An anaerobic digester for the production of methane gas from hog manure based on the design produced by D. Young of Midwest Silos has been constructed.
2. The operation of the system using the manure from the 700-1500 hogs is being tested and monitored.
3. Collection and summary of data on temperature, gas production, energy inputs, loading rates, digestory effects, net yields of energy, and management of operational requirements will be detailed in the final report.

REPORTS

STATUS AND COMMENTS

The unit has operated producing approximately 3000 cu.ft/day of biogas under operating conditions. Problems have been encountered particularly in regards to mixing in the digester. Modifications are being made to the system to upgrade safety standards and overcome mixer problems.

PROJECT DATA

62

TITLE Design & Assessment of a Thermophillic Farm Scale Methane Digester

CONTRACT # 07SZ.01843-9-1910 (OSZ78-00242)

ORGANIZATION Rush Engineering Services Ltd.
R.R. #2
Listowel, Ontario. N4W 3G7

PRINCIPAL INVESTIGATOR Richard Rush, Burlington, Ontario
(416) 634-8994

DURATION February 15, 1979 - May 14, 1982

COST $55,227

SPONSOR Agriculture Canada

SCIENTIFIC AUTHORITY R. Hocking
Engineering & Statistical
Research Institute
Research Branch
Agriculture Canada
Ottawa, Ontario. K1A 0C6
(613) 995-9671

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1979-80	$35,227			$35,227
1980-81	$ 3,000			$ 3,000
1981-82	$17,000			$17,000

OBJECTIVE

1. Design a full-scale thermophillic anaerobic digester to operate on the centrifuged effluent from beef cattle manure. To undertake an operation/monitoring/experimentation program on the digester system including start-up, optimization and mixing studies.

2. To review the technical and economic aspects of utilization and storage of biogas on the Roslyn Park Farm and to design a suitable storage/utilization system.

DESCRIPTION

1. Brief progress reports shall be submitted on the following:

   a) Design
   b) Construction
   c) Start-up
   d) Experimentation

2. An experimental design plan shall be submitted prior to the tests being carried out.

3. A final report shall include the following:

   a) The detailed design of the system;
   b) proposed design of gas storage and utilization system;
   c) description of construction procedures and problems;
   d) details of start-up, operation and optimization of system;
   e) results of mixing trials.

REPORTS

STATUS AND COMMENTS

Design has been completed and construction commenced at Roslyn Park Farms. Construction of the full scale installation is jointly funded by Roslyn Park Farms and Environment Canada under the DREET Program.

PROJECT DATA

115

TITLE Evaluation of downflow anaerobic fixed film reactors for methane production from wastes

CONTRACT #

ORGANIZATION
National Research Council
Biological Fuels Laboratory
Division of Biological Sciences
Rideau Falls Building
Ottawa, Ontario. K1A 0R6

PRINCIPAL INVESTIGATOR L. van den Berg, K.J. Kennedy
S. Duff (613) 992-3310

DURATION 1978 - 1985

COST $511,000

SPONSOR Division of Biological Sciences, NRC.

SCIENTIFIC AUTHORITY

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1978-79	$ 63,000			$ 63,000
1979-80	$118,000			$118,000
1981-82	$130,000			$130,000
1982-83	$200,000			$200,000

OBJECTIVE

To determine the performance of downflow anaerobic fixed film reactors for the production of methane from wastes, including the development of engineering data necessary for the scaling-up of laboratory reactors to pilot-plant size.

DESCRIPTION

In downflow anaerobic fixed film reactors the bacteria converting biomass to methane are grown on a solid support and are therefore not washed out. Advantages apparent from laboratory tests are:

(a) high rates of methane production (up to 5 m^3/m^3/day),

(b) self-mixing,

(c) no channelling,

(d) no plugging,

(e) simple operation,

(f) able to withstand hydraulic overloading and organic shockloads.

These tests were made with many food processing, chemical industry and municipal wastes. Studies are continuing on factors such as:

(a) recirculation rate,
(b) film support,
(c) nutrient supply,
(d) type of waste,
(e) start-up.

REPORTS

Effects of Temperature and Overloading on the Performance of Anaerobic Fixed Film Reactors by K.J. Kennedy and L. van den Berg, May 1981. NRCC No. 19322.

Effect of Substrate Composition on Methane Production Rates of Downflow Stationary Fixed Film Reactors by L. van den Berg and K.J. Kennedy, 1982. NRCC # 19320.

Advanced Fixed Film Reactors for Microbial Production of Methane from Waste by K.J. Kennedy, L. van den Berg and W.D. Murray, 1981. NRCC # 19320.

Support Materials for Stationary Fixed Film Reactors for High-rate Methanogenic Fermentations by L. van den Berg and K.J. Kennedy, 1981. NRCC # 19320.

Effects of Film Area-to-Volume Ratio, Film Support, Height and Direction of Flow on Performance of Methanogenic Fixed Film Reactors by L. van den Berg and C.P. Lentz, January 1980. NRCC No. 17998.

STATUS AND COMMENTS

Results were confirmed in larger scale test in an industrial laboratory and at the Wastewater Technology Center in Burlington. Larger scale systems (up to 400 m^3) are now being planned.

PROJECT DATA

125

TITLE Development of advanced anaerobic treatment technologies for the production of methane from waste.

CONTRACT #

ORGANIZATION Cooperative project of the Waste Water Technology Center of Environment Canada and the National Research Council

PRINCIPAL INVESTIGATOR Dr. B.E. Jank, E. Hall and L. van den Berg

DURATION 1979 - 1982

COST $276,900

SPONSOR Biological Sciences, NRC

SCIENTIFIC AUTHORITY

L. van den Berg
Biological Sciences
National Research Council
Ottawa, Ontario. K1A 0R6
(613) 992-3310

FUNDING

FISCAL YEAR	NRC SPONSOR	CONTRACTOR	ENV.	TOTAL
1979-80	$20,000		$60,800	$ 80,000
1980-81	$77,200		$34,000	$111,200
1981-82	$68,000		$27,500	$ 85,700
1982-83	$76,600			$ 76,600

OBJECTIVE

To develop a data base for comparison and process design for four advanced technologies: anaerobic filter, anaerobic fluidized bed reactor, upflow anaerobic sludge blanket reactor and fixed-film reactor.

DESCRIPTION

Pilot plant studies will be carried out by Environment Canada at the Waste Water Technology Centre in Burlington in cooperation with NRC. These studies with about 1 m^3 reactors will evaluate the above mentioned technologies for the generation of fuel grade methane gas from industrial and municipal wastes. Data obtained during these studies will be used to assess the problems associated with scale-up and to establish an adequate information base for full scale process design.

REPORTS

STATUS AND COMMENTS

The objectives of the current contract have been achieved and a final report will be filed. It was concluded that before an operational pilot plant can be promoted some work needs to be done on process controls.

PROJECT DATA

135

TITLE Development and Demonstration of Thermophilic Anaerobic Fermentation Technology

CONTRACT # KE204-9-424 (08879-105)

ORGANIZATION Roslyn Park Farm
R.R. #2
Peterasburg, Ontario
N0B 2H0

PRINCIPAL INVESTIGATOR Mr. R.C. Bechtel

DURATION December 1979 - March 1982

COST $231,385

SPONSOR Environment Canada (DRECT)

SCIENTIFIC AUTHORITY Mr. D. Campbell
Waste Management Branch
Department of Environment
16th Floor, Place Vincent Massey
351 St. Joseph Blvd.
Hull, Québec
K1A 1C8

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1979-80	$100,000			$100,000
1980-81	$ 95,020			$ 95,020
1981-82	$ 42,400			$ 42,400

OBJECTIVE

To supply and install a full-scale thermophilic anaerobic fermentation system for manure, at Roslyn park Farm and to institute a start-up program and an extended performance monitoring program.

DESCRIPTION

1. Equipment acquisition, construction and management.
2. Plant start-up will consist of 2 weeks for electrical and mechanical testing and eight weeks for biological seeding and acclimatization.
3. Performance monitoring:
   a) fluoride tracer studies for mixing performance;
   b) determine volatile solids and COD removal efficiency, the quality and quantity of the gas produced and assess the reliability and stability of the TAF plant;
   c) post-fermentation nitrogen recoveries and protein characteristics;
   d) suitability of single cell protein as feed supplement;
   e) total energy requirements for the system.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

203

TITLE Biogas Production from Manure

CONTRACT # Strategic Grant

ORGANIZATION Bio-resources Engineering
Nova Scotia Technical College
Halifax, Nova Scotia
B3J 2X4

PRINCIPAL INVESTIGATOR K.V. Lo

DURATION November 1979 - November 1982

COST $49,815

SPONSOR Natural Sciences & Engineering Research Council

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1979-80	$15,000			$15,000
1980-81	$16,470			$16,470
1981-82	$18,345			$18,345

REPORTS

Related publications as of 1979.

Lo K.V., and Clayton J.T., "Nutrient Removal from Secondary Effluent by Soil", Can. Agric. Eng. 20(1): 64-49, June 1978.

Lo K.V., "The Infiltration Characteristics of Dairy Waste Lagoons", Manuscript submitted for publications, 1979.

Ogden J.G., Waller D.H., and Lo K.V., "Nutrient Value and Application Procedure for Digested Sludge on Regenerating Forest Land", A report prepared for Nova Scotia Environmental Control Council, Halifax N.S., February 1979.

Burney J.R., Lo K.V., and Carson W.M., "Dairy Waste Management Design Manual - Phase II", A report to Agriculture Canada, DREAM Program Contract Serial OSZ77-00252, NSTC, Halifax, N.S., March 1979.

OBJECTIVE

To evaluate the potential of biogas generation from animal manure as an alternative energy source in Canada;
2. To design, construct, and compare two pilot-scale anaerobic digesters based on two different concepts (plug-flow and complete mixed reactors);
3. To field test and demonstrate the pilot units to farmers and other interested bodies under actual field conditions;
4. To make recommendations on the design of a commercial unit;
5. To study the alternatives of on-site energy utilization and conversion techniques;
6. To study the storage problem and the safety aspect of biogas production.

DESCRIPTION

It is proposed that this project be carried out in three phases. Each phase will require a period of one year. The work to be carried out in each phase is described below.

Phase I: a) Collection and analysis of data presently available; b) Detailed analysis of design parameters involved in biogas production; c) Study of the alternative energy conversion techniques will be evaluated to suggest a first step of biogas utilization on farms; d) Design of biogas pilot-plants.

Phase II: a) Biogas pilot-plant construction - Based on the detailed design in Phase I the pilot-plants will then be constructed on a dairy farm to evaluate the biogas digester operation. b) Field test and demonstration - In this stage, the pilot-plants will be operated gradually until they reach stability and full capacity. When they are functioning properly, they will then be demonstrated to farmers or those who are interested.

Phase III: a) Evaluation of on-site energy conversion - It is believed that a large portion of the biogas produced will be used for barn heating. The possible alternatives or combinations will be evaluated for their practicalities in order to improve the efficiency of biogas utilization. The use of biogas as an energy fuel to run an internal combustion engine for electric power generation will be studied. b) Recommendations for commercial unit design - Recommendations for commercial units suitable for Nova Scotian conditions will be made so that they can be manufactured in the province. c) Plans for Biogas Plant of Various Capacities - A series of design plans for biogas production units with various capacities will be prepared to meet the need of different agricultural operations. d) Possible Integration of Solar Heating with Biogas Production - It is possible that solar energy may be used to facilitate biogas generation. The feasibility will be evaluated in this step. e) Study of Storage and Safety Problems - Throughout Phase III the pilot-plant would be used as on-site field test and demonstration facility to further promote such techology.

STATUS AND COMMENTS

Working in collaboration with J.D. MacAulay.

4.3.6.1 Biomass Conversion Technologies/Biogas Production. 21/3/82

PROJECT DATA

211

TITLE Anaerobic Digester Mixing Study

CONTRACT # OSE80-00089

ORGANIZATION International Environmental Consultants
5233 Dundas Street W.
Suite 410
Islington, Ontario M9B 1A6

PRINCIPAL INVESTIGATOR B.E. Jank

DURATION September 1980 - February 1983

COST $129,300

SPONSOR Environment Canada and
the Bioenergy Program of N.R.C.

SCIENTIFIC AUTHORITY Eric Hall
Wastewater Technology Centre
Environment Canada
Box 5050, 867 Lakeshore Road
Burlington, Ontario
L7R 4A6

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR	N.R.C.	TOTAL
1980-81	$71,400		$40,000	$101,200
1981-82			$20,500	$ 20,500
1982-83			$ 7,600	$ 7,600

OBJECTIVE

It is evident from tracer studies that only a fraction of the available volume in existing digesters actually is being used. Thus many existing digesters are significantly oversized. This study proposes to determine the levels of mixing required to achieve the maximum rates of digestion.

DESCRIPTION

1. A full-scale study on the effects of mixing on digester performance will be carried out, since current theory does not allow reliable scale-up. One of the existing 55 foot diameter primary digesters in Brantford will be used.

2. Initially mixing will be optimized to the normal loading rates of 0.127lb/ft^3/day. Following this higher loading rates will be employed to quantify the degree of improvement by mixing.

3. The Carter gas gun system will be used for mixing.

4. The following two groups of parameters will be monitored: a) indicators of perfomance: sludge volume, fixed and volatile solids, gas production and gas composition; b) digester environmental conditions: metals, temperature, pH, total nitrogen, and volatile acids.

5. Another digester will be used as an experimental control.

REPORTS

STATUS AND COMMENTS

The Government of Ontario is also contributing $127,300 to this study in the following manner: FY 1980-81, $30,000; 1981-82, $40,000; 1982-83, $56,600.

PROJECT DATA

237

TITLE: Upgrading Waste Biomass into Methane Fuel Gas by Anaerobic Fermentation

CONTRACT #: Strategic Grant

ORGANIZATION: Department of Chemical Engineering
Waterloo University
Waterloo, Ontario
N2L 3G1

PRINCIPAL INVESTIGATOR: M. Moo-Young

DURATION: 3 years

COST: $60,600

SPONSOR: Natural Sciences and Engineering Research Council

SCIENTIFIC AUTHORITY: N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$22,200			$22,200
1982-83	$22,200			$22,200
1983-84	$16,200			$16,200

OBJECTIVE

In the proposed research, we plan to apply our previously-attained expertise in anaerobic digestion in order to develop a free-standing anaerobic fermentation process which will generate fuel gas as the main product. We intend to determine the solids conversion efficiency (liters gas produced/g solids added) and the concomitant gas generation rate for a range of agricultural and forestry wastes (separately and in combinations) which are widely available in Canada. The experimental work will be performed in existing demonstration units now being operated in our laboratories. The results will be used to perform an engineering analysis of the process energy budget for the various cases and to perform a detailed economic analysis of a number of scenarios pertinent to the types of raw materials available in representative regions of Canada.

DESCRIPTION

The work program is divided into four areas:

a) a state-of-the art review of the relevant literature
b) design and construction of experimental equipment
c) experimental studies of co-digestion of manures and cellulosic residues, selected as grass, straw and corn stover
d) development and application of a computer program for process economic evaluations.

REPORTS

Related publications.

Chahal D.S., Vlach D. and Moo-Young M., "Effect of physical and physicochemical pretreatments of wood for SCP production with C. cellulolyticum", Biotechnol. Bioeng., In press (Accepted March 1981).

Moo-Young M., Chahal D.S. and Stickney B., "Pollution control of swine manure and straw by conversion to C. cellulolyticum SCP feed", Biotechnol. Bioeng., In press (Accepted March 1981).

Moo-Young M. and Macdonald D.G., "Improved economics of the Waterloo SCP process by increased growth rates", Biotechnol. Letters, 3, 149-152 (1981).

Gonzales-Valdes A. and Moo-Young M., "Production of yeast SCP from corn stover hydrolysates", Biotechnol. Letters, 3, 143-148 (1981).

STATUS AND COMMENTS

Working in collaboration with J.M. Scharer and C.W. Robinson. See project #38 for previous work under Strategic Grant 1978-1981.

The evaluations for agricultural wastes (in the form of cattle and swine manures) and crop residues (in the form of corn stovers) are nearing completion and process design criteria are being established. The experimental research on forestry wastes have not yet started. Equipment is now in place to test the potential utilization of forestry residues for biogas production with concurrent pollution abatement of the wastes.

PROJECT DATA

247

TITLE: Conversion of Food Waste to Methane.

CONTRACT #: 31155-0-0625 (OSX80-00088)

ORGANIZATION: Canadian Canners Ltd.
Research Centre
1101 Walkers Line
Burlington, Ontario L7V 2G4

PRINCIPAL INVESTIGATOR: T.G. Stevens

DURATION: November 1980 - March 1982

COST: $57,897

SPONSOR: National Research Council - PILP

SCIENTIFIC AUTHORITY: J. Vose
National Research Council
Room 310, Building M-58
Ottawa, Ontario
K1A 0R6
(613) 993-0357

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$ 16,560			$ 16,560
1981-82	$ 41,337			$ 41,337

OBJECTIVE

To evaluate technical and economic factors involved in conversion of various food wastes to methane, using an anaerobic fixed film reactor.

DESCRIPTION

1. Study the effect of temperature on reactor performance (bean blancher waste).
2. Study the effect of intermittent shut-down on subsequent reactor performance (methane production and COD removal - bean blancher and beet wastes)
3. Study the effect of waste composition on reactor performance (beet, pear peel and tomato wastes).
4. Assessment of quantity and characteristics of available wastes from 4 food processing operations in South Western Ontario.
5. Analysis of feasibility of utilizing complementary wastes for year-round operation of AFF reactor (undigested sewage sludge etc.).
6. Appraisal of process fuel requirements in a selected processing plant.
7. Determination of reactor facility requirements including design characteristics, cost estimates including auxiliary facilities (waste storage etc.).
8. Financial analysis to determine overall impact of the proposed AFF reactor.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

175

TITLE: Conversion of Cellulose to Ethanol Using a Two Stage Process

CONTRACT #: LX229-1-4115 OSS81-00032 C-181

ORGANIZATION: Forintek Canada Corporation
Eastern Laboratory
800 Montreal Road
Ottawa, Ontario
K1G 3Z5

PRINCIPAL INVESTIGATOR: J.K. Shields

DURATION: May 1981 - March 1983

COST: $187,822

SPONSOR: Environment Canada

SCIENTIFIC AUTHORITY: C.R. Mackenzie
Rideau Falls Laboratory
National Research Council
Sussex Drive
Ottawa, Ontario

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$ 85,270			$ 85,270
1982-83	$102,552			$102,552

REPORTS

OBJECTIVE

1. To compare the cellulose enzyme systems of Trichoderma reesei C30 and the highly cellulolytic Trichoderma strains present in the Forintek culture collection.
2. To continue to screen for highly cellulolytic fungi present in the collection. To develop the production of a cellulase mixture which can convert cellulose to glucose fast and efficiently.
3. To establish a two-stage process of producing ethanol from cellulose. First, by converting cellulose to glucose using the best enzyme mixture. Secondly, converting the liberated glucose to ethanol using a high ethanol producing and ethanol tolerant Saccharomyces.
4. To scale this procedure up to a continuous process using a variety of different cellulosic substrates.

DESCRIPTION

1. Production of cellulase enzymes
a) Growth of 3 different cellulolytic fungi; b) Determine optimum conditions for growth and enzyme production; c) Assay for enzyme activity using filter paper, endogluconase and B-glucosidase assay methods; d) Determine growth and enzyme production of fungi, grown on different pretreated substrates; e) Establish storage methods for retaining activity of cellulase enzymes prior to addition to ethanol production step; f) Enzymatic hydrolysis of different pretreated wood substrates and commercially available substrates assaying for reducing sugars and glucose.

2. Growth of ethanol producing Saccharomyces
a) Growth of 2 different Saccharomyces strains; b) Assay for ethanol production of glucose; c) Develop assay methods for ethanol using programable gas chromatograph; d) Assay for utilization of reducing sugars and glucose; e) Establish optimum conditions for ethanol production.

3. Establishing two stage system
a) Production of enzyme preparation which can convert cellulose to glucose; b) Establish simultaneous saccharification and fermentation with enzymatic hydrolysis and ethanol fermentation of the cellulose derived glucose; c) Assay for efficiency of conversion of cellulose to glucose glucose to ethanol.

4. Preliminary tests to scale the optimum methods up to the mini-pilot plant level using a 30 litre fermenter. Attempt semi-continuous production of ethanol from cellulose.

STATUS AND COMMENTS

4.3.6.2 Biomass Conversion Technology/Fermentation to Alcohol. 19/04/82

PROJECT DATA

176

TITLE Liquid Fuel Production from Hemicellulose

CONTRACT # KL229-1-4116 OSS80-00033 C-187

ORGANIZATION Forintek Canada Corporation
Eastern Forest Products Laboratory
800 Montreal Road
Ottawa, Ontario
K1G 3Z5

PRINCIPAL INVESTIGATOR J.K. Shields

DURATION April 1981 - March 1983

COST $155,692

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY I. Veliky
Biological Sciences
National Research Council
Sussex Drive
Ottawa, Ontario

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$58,683			$58,683
1982-83	$97,009			$97,009

OBJECTIVE

The aim is to produce hemicellulose, hydrolyse it and to ferment the released sugars by aerobic and anaerobic organisms.

DESCRIPTION

1. To isolate and identify the hemicellulose fraction from a variety of different wood substrates and to compare the efficiencies of direct extraction or extraction following pretreatment.

2. To compare the relative efficiencies of chemical and enzymatic hydrolysis of hemicellulose fractions and to establish analytical methods for determining the degree of hydrolysis. To achieve conditions for chemical hydrolysis which allow maximum release of the composite monosaccharides without degrading these liberated sugars. To establish an enzyme system which will actively degrade all of the various hemicellulose fractions.

3. To optimize the production of power solvents from hemicellulose derived sugars by anaerobic bacteria and to initiate studies to decrease the butanol toxicity of some of these microbes.

4. To optimize the production of butanediol and ethanol by aerobic bacteria grown on hemicellulose and cellulose-derived sugars and the establishment of continuous culture conditions.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

199

TITLE Novel Technology for Gasohol Production by Fermentation

CONTRACT # Strategic Grant

ORGANIZATION Dairy and Food Science
University of Saskatchewan
Saskatoon, Saskatchewan
S7N 0W0

PRINCIPAL INVESTIGATOR W.H. Ingledew

DURATION 3 years

COST $102,762

SPONSOR Natural Sciences & Engineering Research Council

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$33,000			$33,000
1981-82	$36,762			$36,762
1982-83	$33,000			$33,000

REPORTS

OBJECTIVE

The overall objectives of this study are to improve economics of production of alcohol to be used as an alternate energy source in automobiles as gasohol, to develop a starch substrate-based single cell protein (fodder yeast) production, and to use genetic manipulatio (engineering) to advance the application of biotechnology to world problems.

DESCRIPTION

This can only be done after the appropriate genetic engineering, and therefore the project in brief would involve:

1) routine screening of yeasts of a variety of genera f starch degradation (genetic) characteristics (completed - 1979-80)
2) assessment of amylase-amyloglucosidase enzyme compliment
3) application of transformation and spheroplast fusion genetic procedures (Dr. G. Khachatourians, microbial geneticist, Dept. of Microbiology)
4) assessment of resultant starch positive Saccharomyce yeasts for alcohol yield and SCP yield from starch. Appropriate yeasts should have high growth rates on starch, good enzyme production, high ethanol or biomass yields, and higher optimum temperatures to reduce cooling costs in propagators. Assessment of associative fermentation techniques
5. construction of a detailed economic study.

It is felt that this project may have future economic potential as a versatile yeast enterprise. For example in a small brewery-type facility using "inexpensive" starch, end products (by-products) could include spent grains (animal feeds), ethanol, and primary or secondar yeasts. Yeasts made from starch (rather than imported molasses) could be active or inactive and could be use food, feed, or for industrial use. The brewing, baking and distilling industries themselves could use the facilities of an independent yeast manufacturing plant which could act as a distribution center for custom-ma yeast creams, press cakes or dried active yeasts. Per a small localized plant could also help these industri with yeast inactivation, preservation and feed yeast preparation from spent yeasts.

STATUS AND COMMENTS

Working in collaboration with G.G. Khachatourians.

PROJECT DATA

214

TITLE Production of Ethanol by Fermentation

CONTRACT # OISU.01843-0-B102 (OSU80-245)

ORGANIZATION Faculty of Engineering Science
University of Western Ontario
London, Ontario

PRINCIPAL INVESTIGATOR Dr. N. Kosaric

DURATION January 1981 - March 1982

COST $75,000

SPONSOR Agriculture Canada

SCIENTIFIC AUTHORITY D. Hayes
Engineering & Statistical Institute
Building 94
Agriculture Canada
Ottawa, Ontario

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$15,000			$15,000
1981-82	$60,000			$60,000

OBJECTIVE

To select and develop microbial systems that are presently not used in industry for alcohol production from carbohydrate rich sources.

DESCRIPTION

1. Select a substrate which would be a high carbohydrate or sugar source available in large quantities in Canada or with a potential of being produced in large quantities. Alternative carbohydrate sources to be investigated are:
   - sugar beets
   - Jerusalem artichoke
   - potato and other root crop culls
   - industrial and/or agricultural residues, cheese whey in particular
2. Select and develop microbial systems that are presently not used industrially for alcohol production and optimize fermentation systems. The microbes in question are "unconventional" yeast, e.g. Saccharomyces diastaticus and bacteria, e.g. Zymomonas species. Other organisms known to produce high alcohol concentrations will also be examined. The objective is to achieve high alcohol yields over and above the conventional yeilds and concentrations that are presently obtained in beverage alcohol production. A variety of substrates will be investigated including industrial and agricultural wastes.
3. Determine the influence of higher ethanol concentrations on viability and potential growth of the investigated microbes during the study. Optimum conditions for high ethanol yield will be established under batch and continuous process modes in 20 L fermenters and a chemostat.
4. On the basis of results obtained under 1 - 3, and optimum batch or continuous reactor for the above production will be developed and tested for its preformance.
5. Design a process for production of ethanol, including process parameters and economics for a 100,000 gal/yr facility.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

236

TITLE The Development of an Economical Fermentation Process for the Production of Organic Solvents from Biomass

CONTRACT # Strategic Grant

ORGANIZATION Department of Microbiology
Queen's University
Kingston, Ontario
K7L 3N6

PRINCIPAL INVESTIGATOR A.M. Kropinski

DURATION 3 years

COST $185,000

SPONSOR Natural Science & Engineering Research Council of Canada (NSERC)

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$65,000			$65,000
1982-83	$60,000			$60,000
1983-84	$60,000			$60,000

OBJECTIVE

Studies will concentrate on the development of genetically ameliorated bacterial strains which can ferment polymeric carbohydrates into alcohols and other useful compounds in unprecedented yields. The present limitation on solvent production with these organisms appears to be a result of end-product toxicity. Therefore, mutants displaying tolerance to fermentation end-product and insensitivity to intra- and extra-cellular phage and bacteriocins will be developed and exploited. This approach should afford solvents in much higher yields.

DESCRIPTION

The proposed research will concentrate on the development of genetically ameliorated bacterial strains which can tolerate high solvent concentrations. Three facets of the project and the suggested experimental approaches are outlined below.

A) The isolation of cellulose-, hemicellulose- and starch-degrading Clostridium strains and examination of culture supernatants for alcohols and other industrially useful chemicals (e.g. butyric acid).
B) The selection of mutant strains exhibiting increased tolerance to butanol.
C) The isolation of phage-resistant and nonbacteriocinogenic (or non-lysogenic) cultures.

Further specific studies will involve:

A) Selection of mutants with increased levels of starch/cellulose degrading enzymes. With the recent observation that C.acetobutylicum possesses carboxymethylcellulase and cellobiase activity this aspect of the project demands renewed attention. Whereas this organism is unable to degrade native cellulose it has been established that C.acetobutylicum can attack acid-swollen cellulose.
B) Selection of strains which produce solvents in different proportions.
C) The application of microbial genetics and recombinant DNA technology to strain improvement, initially involving the transfer of cellulose-degrading capacity by interspecies transformation using DNA from C. thermocellum or a related cellulose-degrading organism.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

245

TITLE Alcohol from Hardwood Spent Sulfite Liquor Using NRC Pentose Fermenting Yeast.

CONTRACT # Contribution Agreement. CA155-1-0615C/303C

ORGANIZATION CIP Research Ltd.
179 Main Street, West
Hawkesbury, Ontario
K6A 2R4

PRINCIPAL INVESTIGATOR D. Mutton

DURATION July 1981 - March 1982

COST $198,200

SPONSOR National Research Council - PILP

SCIENTIFIC AUTHORITY H. Schneider
National Research Council
Ottawa, Ontario
K1A 0R6
(613) 992-6512

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$108,300	$89,900		$198,200

OBJECTIVE

To produce alcohol from spent sulfite liquor using Tannophilus pachysolen.

DESCRIPTION

Phase I To confirm in the laboratory that Tannophilus pachysolen can successfully ferment hardwood spent sulfite liquor. This has tentatively been shown in our laboratories but not under well controlled and reproducible conditions. In addition, it is necessary to establish the optimum conditions under which such a yeast will operate to produce maximum yields of alcohol with a particular Hawkesbury liquor.

Phase II The Gatineau facilities have fermentation tanks and distillation columns of a size that will enable pilot trials to be carried out with conditions established under objective #1 in order to disclose any potential problems with scaling up.

Phase III Once it has been established that the process operates successfully under pilot scale conditions the next step would be the design and installation of commercial equipment at Hawkesbury and at Gatineau. It is understood that this final phase of the project would not be eligible for PILP support.

REPORTS

STATUS AND COMMENTS

A strain of Pachysolen tannophilus has been selected, via a mutagenesis procedure, which grows on 80% spent sulfite liquor, but the doubling time is slow. Work is continuing to improve tolerance and to reduce doubling time.

PROJECT DATA

246

TITLE Evaluation of D-xylose Fermenting Yeasts on Wood Hydrolysates.

CONTRACT # 31155-1-0673/382 (OSX81-00102)

ORGANIZATION Diversified Research Laboratories Ltd.
1047 Yonge Street
Toronto, Ontario
M4W 2L3

PRINCIPAL INVESTIGATOR G.R. Lawford

DURATION December 1981 - July 1982

COST $83,347

SPONSOR National Research Council - PILP

SCIENTIFIC AUTHORITY J.R. Vose
National Research Council
Ottawa, Ontario
K1A 0R6
(613) 993-0357

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$73,667			$73,667
1982-83	$ 9,680			$ 9,680

OBJECTIVE

To adapt selected NRC yeast strains to growth on hydrolysed wood substrates, and to select those strains that convert the xylose component to alcohol.

DESCRIPTION

1. Yeasts will be evaluated/screened for their ability to produce alcohol from wood hydrolysates based on theoretical maximum alcohol yield.
2. Determination of amount and rate of alcohol produced by various strains of Pachysolen tannophilus and other xylose fermenting yeasts after acclimatization to wood hydrolysates.
3. Analysis for poly-alcohol during the course of fermentation experiments.
4. Evaluation of strain tolerance to various concentrations of wood hydrolysate and to high alcohol and sugar concentrations.
5. Evaluation of alcohol production at increased biomass levels (recycling).

REPORTS

STATUS AND COMMENTS

4.3.6.2 Biomass Conversion Technology/Fermentation to Alcohol. 23/3/82

PROJECT DATA

248

TITLE Production of Alcohol from Spent Sulfite Liquor Using NRC Pentose Fermenting Yeast

CONTRACT # Contribution Agreement. CA155-1-0615/303B

ORGANIZATION Tembec Inc.
Temiscaming, Québec
J0E 3R0

PRINCIPAL INVESTIGATOR

DURATION October 1981 - October 1983

COST $275,456

SPONSOR National Research Council - PILP

SCIENTIFIC AUTHORITY H. Schneider
National Research Council
Ottawa, Ontario
K1A 0R6
(613) 992-6512

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$ 42,149			$ 42,149
1982-83	$113,307			$113,307
1983-84	$ 30,000	$90,000		$120,000

OBJECTIVE

To develop a fermentation system using NRC xylose fermentor for the conversion of spent sulfite liquor to alcohol.

DESCRIPTION

A. Analysis of spent sulfite liquor (SSL) from soft and hardwoods to determine theoretical maximum alcohol obtainable.

B. Determine the amount of ethanol obtainable with brewer's yeast (for standard reference).

C. Determine amount of ethanol obtainable from strains of P. tannophilus from SSL.

D. Sugar analysis of the fermentation broth to determine species and amounts of sugars utilized.

E. Screen xylose fermenting yeasts.

F. Strain improvement by mutagenesis and selective crossing.

G. Optimization of the process.

H. Pilot scale operation.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

69

TITLE Catalytic Pyrolysis and Gasification of Lignocellulosic Materials

CONTRACT # 09SD.K 1229-9-7055 (OSD79-00007) C33

ORGANIZATION Génie chimique
Université de Sherbrooke
Sherbrooke, Québec. J1K 2R1

PRINCIPAL INVESTIGATOR Esteban Chornet (819) 565-4320

DURATION Estimated 3 years

COST $174,656

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale, C.F.S.
Place Vincent Massey
Hull, Quebec. K1A 0K7
(613) 997-1682

TECHNICAL LIAISON OFFICER: R.G. Graham
Forintek Canada Corporation
Eastern Lab
800 Montreal Road
Ottawa, Ontario.
(613) 744-0963

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1979-80	$46,840			$ 46,840
1980-81	$57,300			$ 57,300
1981-82	$70,516			$ 70,516

OBJECTIVE

a) To establish design criteria and parameters, for the development of a system of valorizing lignocellulosic matter involving two distinct, consecutive phases of catalytic pyrolysis and gasification.

b) To study the role and the potential of chemical impregnated and physical additions of metals in terms of reactivity and selectivity in primary and secondary pyrolysis and in gasification of char.

DESCRIPTION

Controlled experiments will be carried out with lignin and cellulose on hardwood and resin trees. Alkaline catalysts will be added or transition metals will be impregnated in the material. Three types will be considered in each category, from the least to the most expensive. The alkalines will be Na_2CO_3, K_2CO_3, Li_2CO_3. The metals will be Fe, Ni or Co, Ru or Pt.

An experimental phase under laboratory conditions will allow a detailed individual study of the three major phases in the reactions involved: primary pyrolysis, secondary pyrolysis, and gasification of the char itself. This study will involve the use of existing reactors. Experiments in thermal gravimetry will also be conducted. The substances will be evaluated and the products resulting from the reactions will be analysed in detail during each test.

A second experimental phase, in the field, involving a revolving furnace with a capacity of 12 kg/h will help develop conceptual criteria.

REPORTS

Pyrolyse et gazéification catalytiques des matières lignocellulosiques Phase I: mai 1979 - mars 1980. Interim Report by Université de Sherbrooke, Sherbrooke, Québec, mars 1981.
(Available from ENFOR Secretriat and Energy Library.)

Pyrolyse Primaire Catalytique de Lignocellulose Préalablement Imprégnée de métal alcalin et de Métaux de Transition, G.R. Bellemare, C. Roy, E. Chornet. Presented at the 2nd Bioenergy R&D Seminar, Ottawa, 1980.
(Available from NRC Publications)

STATUS AND COMMENTS

Primary pyrolysis phase is complete.

PROJECT DATA

151

TITLE A Kinetic and Catalytic Study for the Optimisation of the Fluidized Bed Gasification Process

CONTRACT # KL229-0-4122 (08580-69) C103

ORGANIZATION Forintek Canada Corporation
800 Montreal Road
Ottawa, Ontario
K1G 3Z5

PRINCIPAL INVESTIGATOR H. Tarki

DURATION April 1980 - June 1982

COST $193,504

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.P. Overend
National Research Council
Building M-50
K1A 0R6
(613) 993-3405

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$66,650.93			$66,650.93
1981-82	$98,672.07			$98,672.07
1981-82	$28,181			$28,181

REPORTS

OBJECTIVE

The goals of the kinetic study are to determine the rate (speed) of the chemical process, to identify the factors upon which the rate depends and to arrive at a reaction mechanism. These goals will be accomplished by means of a combined thermogravimetric/differential thermal (TGA/DTA) analyzer which gives the weight loss of a sample with respect to time. The heating rate and temperature range are variable. The resulting data is used in a standard "differential" method to determine the reaction mechanism. Rates can be measured directly from the TGA/DTA apparatus.

DESCRIPTION

Two types of thermogravimetric analysis will be employed.

a) Dynamic TGA - the weight of a sample will be recorded over a temperature range form 25°C to 1000°C. The heating rate wil be set in the range of 2 to 15°C per minute for a variety of runs (i.e. a fixed heating rate, variable temperature).

b) Static TGA - five temperatures will be chosen in the range of 100°C to 1000°C and weight loss recorded as a function of time (fixed temperature). Selection of a given temperature will be based on the dynamic TGA results where rapid weight losses were observed. 500 mg wood samples will be used during the TGA/DTA experiments, and the reacting environment will be steam, nitrogen or air.

The goal of a catalytic study is to identify those catalysts which best enhance a given process in terms of rate, yield and quality of the product. Seven individual catalysts have been selected (based on the literature and past experience), and will be used in conjunction with the TGA apparatus and the small fluidized-bed research gasifier (100,00 BTU/hr). In addition to the use of the singular catalysts (primarily alkali carbonates and transition metals), several combinations (catalyst mixtures) will be employed. The catalysts would be introduced by impregnation and physical addition techniques.

STATUS AND COMMENTS

PROJECT DATA

173

TITLE Development of Analytical Methodology for Biomass Gasification Products

CONTRACT # KL229-1-4114 OSS81-00051 C-172

ORGANIZATION Techwest Enterprises Ltd.
3650 Wesbrook Crescent
Vancouver, B.C.
V6S 2L2

PRINCIPAL INVESTIGATOR G. Kaplin

DURATION April 1981 - March 1983

COST $236,579

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY Dr. D.P.C. Fung
CANMET
Energy, Mines & Resources
580 Booth Street
Ottawa, Ontario.

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$110,280			$110,280
1982-83	$126,299			$126,299

OBJECTIVE

To develop a standard procedure for the collection, separation and analysis of "dirty gas" from biomass gasification so that results from various contractors can be compared meaningfully.

DESCRIPTION

The following are to be determined:

1. Volume rate of the "dirty gas" which is hot (200-400°C) and contains non-condensable gases, tarry liquid and solid particles;
2. Mass of gas, liquid and solid;
3. Quantity of the liquid fraction with special emphasis on the chemical constituents (qualitative analysis) and energy of the tarry materials;
4. Chemical composition and energy content of the gas, liquid and solid.

The principal investigator will visit concerned contractors on a fact-finding mission before the development work. The developed methodology should be simple and versatile for both pilot plant scale (gasification at a rate of 80 kg of biomass per hour) and laboratory scale (1 kg of biomass per hour). Preferably only conventional instruments such as gas chromatography, GC-MS spectrometry and gel permeation chromatography should be applied in this methodology.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

187

TITLE A Comparative Study of Laser Spectroscopic Techniques for Analysis of Biomass Gasifier Products

CONTRACT # KL229-1-4110(08S81-00014) C-240

ORGANIZATION M.P.B. Technologies
P.O. Box 160
21051 North Services Road
Trans Canada Highway
Ste-Anne-de-Bellevue, Québec H9X 3L5

PRINCIPAL INVESTIGATOR Dr. M.P. Bachynski

DURATION April 1981 - August 1981

COST $31,281

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Place Vincent Massey
Hull, Québec

TECHNICAL LIAISON OFFICER: R.G. Graham
Forintek Canada Corporation
Eastern Laboratory
800 Montreal Road
Ottawa, Ontario
K1G 3Z5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$31,281			$31,281

OBJECTIVE

To study and compare the applicability of techniques based on several types of laser spectroscopy, namely Raman spectroscopy, coherent ant-Stokes Raman spectroscopy and stimulated Ranan gain spectroscopy for gas analysis in biomass gasifiers. An experimental system design for the laboratory demonstration of the most promising technique will be prepared.

DESCRIPTION

The different Raman spectroscopy techniques will be compared to determine their suitability for gas constituent analysis for biomass gasifiers. The techniques will be compared on the basis of detection sensitivity and accuracy, time required for analysis, complexity of operation, maintenance requirements, and costs.

1. A detailed study of spontaneous Raman spectroscopy. A variety of scattering geometries will be considered with particular emphasis on the resulting S/N ratio and stray-light rejection problems.

2. A detailed study of coherent ant-Stokes Raman spectrocopy (CARS). One of the key components of the study will be a comparative examination of variations of the basic CARS technique such as multiple CARS, BOXCARS and polarization and background suppression.

3. An examination of stimulated Raman gain spectroscopy (SRGS) variations of the basic techniques, such as heterodyned polarization interferometry and two-beam non-linear interferometry will be examined.

4. A comparative study of 1 - 3 and a selection of the optimum technique.

5. A detailed system design for a laboratory demonstration of the technique selected, together with projected performance specifications and cost.

REPORTS

STATUS AND COMMENTS

Project completed as of August 1981. Report to be submitted.

PROJECT DATA

240

TITLE Design Study for Wood Gasifier/Engine Test Project

CONTRACT # 31155-1-2671 (OSSX81-00110)

ORGANIZATION Omnifuel Gasification Systems Ltd.
3284 Yonge Street, Suite 501
Toronto, Ontario
M4N 3M7

PRINCIPAL INVESTIGATOR Keith Bircher

DURATION December 1981 - March 1982

COST $34,080

SPONSOR National Research Council

SCIENTIFIC AUTHORITY R.P. Overend
National Research Council
Room 206, Building M-50
Ottawa, Ontario
K1A 0R6
(613) 993-3405

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$34,080			$34,080

OBJECTIVE

To develop a design necessary for the installation of a wood gasifier/engine system.

DESCRIPTION

Task 1:
Prepare a review of commercially-available equipment for the scrubbing, cooling and filtration of gases containing water vapour and for the clarification of wash water; of engine manufacturers capable of building low heating value gas engines (greater than 1MW).

Task 2:
Process design, including heat and mass balance, pipe sizing, particulate and tar removal efficiency evaluation and equipment specification.

Task 3:
Mechanical design, including layout drawings, building design, piping and instrumentation drawings, project estimates.

Task 4:
Test equipment evaluation.

Task 5:
Preparation of a final report incorporating the results of Tasks 1 to 4 inclusive, to be submitted no later than March 31, 1982.

REPORTS

STATUS AND COMMENTS

PROJECT DATA 30

TITLE Demonstration and Testing of a "Lamb" Wet-Cell Wood Burner using Hogged Wood Waste for Firing a Pulp Mill Lime Kiln

CONTRACT # OSSB.KL016-8-0125 (OSB78-00341), SP8, C14

ORGANIZATION Lamb-Cargate Industries Ltd.,
P.O. Box 440, 1135 Queens Ave.,
New Westminster, B.C. V3L 4Y7

PRINCIPAL INVESTIGATOR Ian Rowe

DURATION February 12, 1979 - May 1982

COST $2,070,000

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale, C.F.S.
Vincent Massey Building
Hull, Quebec. K1A 0E7
(613) 997-1682

TECHNICAL LIAISON OFFICER: Dr. J.F.G. Mackay
Forintek Canada Corporation
Western Laboratory
6620 N.W. Marine Drive
Vancouver, B.C. V6T 1X2
(604) 224-3221

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR	I.T. & C.	TOTAL
1978-79	$400,000	$300,000	$200,000	$900,000
1979-80	$300,000	$300,000	$200,000	$800,000
1981-82	$250,000			$250,000
1982-83			$120,000 (NRC)	$120,000

OBJECTIVE

To demonstrate energy conservation to the pulp and paper industry by displacing petroleum derived energy with green wood wastes.

DESCRIPTION

An innovative technique for using wood waste, developed by Lamb-Cargate Ltd. will be employed at the MacMillan-Bloedel pulp mill at Port Alberni.

Oil is currently used to heat the No. 1 lime kiln. Aim of the project is to show the feasibility of using a wet cell/ - one permitting the use of rough wet waste of all types. Oil and natural gas have been the preferred fuels in the past for technical reasons. Throughout the industry, lime kilns require large quantities of oil or natural gas. The Port Alberni experiment could be important in showing how to cut down on increasingly costly oil and natural gas. Computer simulation indicates the potential for at least 60 per cent substitution of the oil used in the lime kiln by waste wood converted to hot gases in the wet cell burner.

Lamb-Cargate has designed, constructed and installed the 60 million BTU/hour wet cell. (This is a follow-up to development of a 20 million BTU/hour prototype - at the Plateau Mills Ltd. sawmill at Vanderhoof, B.C.)

MacMillan Bloedel will provide fuel testing operating and maintenance facilities and scientific assessment of the burner performance.

REPORTS

STATUS AND COMMENTS

Preliminary operation though promising has revealed a number of technical difficulties. A technical program to be supported by NRC in 1982 is expected to remedy problems of flame stability and the optimization of the kiln/wet cell combination.

PROJECT DATA

153

TITLE Wood Residues as Fuel for Lime Kilns

CONTRACT # 42SS.KL229-0-4121 (OSS80-35) C123

ORGANIZATION Pulp & Paper Research Institute of Canada
570 St. John's Blvd
Pointe Claire, Quebec. H9R 3J9

PRINCIPAL INVESTIGATOR R.J. Philp

DURATION April 1980 - March 1982

COST $262,877

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Canadian Forestry Service
19th Floor, Place Vincent Massey
Hull, Québec K1A 1G5

Technical Liaison Officer: D.R. Huffman
Forintek Canada Corp.
800 Montreal Road
Ottawa, Ontario K1G 3Z5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$163,977			$163,977
1981-82	$ 98,900			$262,877

REPORTS

Wood Residues as Fuel Source for Lime Kilns by R.J. Philp, M.K. Azarniouch, Pulp and Paper Research Institute of Canada, August 1981.
(Available from ENFOR Secretariat or CISTI Energy Library)

OBJECTIVE

1. To study two specific approaches for changing the combustion technology for lime kilns to achieve complete or nearly complete replacement of fossil fuels by biomass using (i) in-situ combustion and (ii) direct firing of hog-fuel and other wood residues. Special emphasis is to be placed on maintaining the throughputs and conversion efficiencies in existing lime kilns.

2. To assess the possible adverse effects of inorganic contaminants and, if necessary, to develop and test corrective measures.

DESCRIPTION

1. Modification of the Fuller Company's pilot kiln. This would entail the installation of an appropriate chain system in the kiln, and the provision of a suitable hog fuel feeder.

2. Two test runs using a mill lime mud as a source of calcium carbonate. This will entail the in-situ combustion of hog fuel to achieve near-complete replacement of fossil fuel.

3. Preparation of the final report including economic estimates, and preliminary design of mill-scale trials.

STATUS AND COMMENTS

Feeding wet hog fuel with calcium carbonate grit directly into the cold end of a pilot kiln resulted in a fossil fuel replacement of approximately 20%. Due to the high heat losses in the kiln used, this reduction corresponds to over 70% of the fossil fuel requirements of a mill kiln.

The presence of hog fuel contaminants resulted in some reduction in the causticizing efficiency and/or the settling rate of the lime mud in the white liquor.

Work is continuing to find solutions to the problems associated with hog fuel contaminants as well as to carry out additional pilot experiments using larger kiln equipment with a chain system, an induced draft fan and higher length to diameter ratio.

PROJECT DATA

172

TITLE Evaluation of Rapeseed Oil as Diesel Fuel

CONTRACT # 01706-0-100 (08280-65)

ORGANIZATION Saskatchewan Research Council
30 Campus Drive
Saskatoon, Saskatchewan. S7N 0X1

PRINCIPAL INVESTIGATOR B. Zuk

DURATION June 12, 1980 - August 13, 1981

COST $87,000

SPONSOR Agriculture Canada

SCIENTIFIC AUTHORITY M. Stumborg
Research Station
Dept. of Agriculture
Swift Current, Saskatchewan
S9H 3X2

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$52,000			$52,000
1981-82	$35,000			$35,000

OBJECTIVE

To study the feasibility of using rapeseed oil as a diesel fuel extender or substitute.

DESCRIPTION

1. To determine the technical feasibility of using rapeseed oil as a diesel fuel extender or substitute. The two groups of rapeseed to be tested are Regent to cover the double "0" variety, and a high erucic variety (to be chosen later) to include the superior lubricating characteristics plus the potential higher yielding non-edible oil seed.

2. To compare various grades of extracted oil ranging from refined to crude with standard diesel fuel on the basis of a fuel for conventional diesel engines.

3. To run engine trials on a two and six cylinder engine with the grades of oil fuel that hold the greatest promise based on tests in (2) above.

4. To investigate the effect on engine performance and the problems involved in using a three-way blend of diesel-vegetable oil-alcohol.

5. To investigate diesel fuel as a solvent for oil extraction. This method may have merit if an on-farm extraction system is possible.

6. To investigate the feasibility of small, on-farm vegetable oil expeller (extractor) units.

REPORTS

Canola Oil as Fuel for Farm Diesel Engines, by B. Zuk, J. Blake, W. Craig, E. Cosworth and R. Strayer, Agriculture Canada. September 1981. Final report for Phase I.
(Available from Agriculture Canada, Ottawa and Saskatchewan Research Station)

STATUS AND COMMENTS

Phase I is complete. Work in this area is continuing under a new contract (see project #242).

PROJECT DATA 186

TITLE Coordination of the test program on boilers burning wood refuse

CONTRACT # KL229-1-4124-B C-235

ORGANIZATION Canadian Boiler Society
1 Yonge Street, Suite 1400
Toronto, Ontario
M5E 1J9

PRINCIPAL INVESTIGATOR

DURATION August 5, 1981 - November 30, 1981

COST $33,000

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY G.K. Lee
Canadian Combustion Research Lab
Energy Research Laboratories
Bells Corners Complex
C/O 555 Booth Street
Ottawa, Ontario
K1A 0G1
(613) 996-4570 ext. 186

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$33,000			$33,000

OBJECTIVE

To identify boiler installations which reflect post 1976 combustion and control technology, and to perform detailed efficiency and emissions tests on selected units.

DESCRIPTION

Task 1 The contractor shall perform whatever work may be required to assist in the planning of the total program.

Task 2 (A) Together with representatives of governments, K.V.B. Inc., Babcock and Wilcox Canada Ltd. and Combustion Engineering Super Heater Ltd. the contracter shall make a visit to Newcastle, NB to assess the capability of steam generators operated by Boise Cascade to fire wood refuse. The boilers should preferably be rated at 100,000 lb/h of steam or more.

(B) To determine
(i) current technology features
(ii) which units can separately fire different types of wood refuse
(iii) which units are most appropriate for measuring ASME indirect boiler efficiencies and EPA emissions characteristics

(C) To identify one boiler for detailed field evaluations.

Task 3 Detailed test plans specifying firing conditions, loads and fuels, emissions measurements, sampling points, and combustion data.

REPORTS

STATUS AND COMMENTS

Work complete. Final report expected. Field tests will start in Newcastle and all contract work will be coordinated by the Canadian Boiler Society.

4.3.6.6 Biomass Conversion Technology/Direct Combustion.

23/3/82

PROJECT DATA

212

TITLE Effect of particle size on the gross heat of combustion of wood

CONTRACT # KH107-1-4318(08881-00110) C-257

ORGANIZATION Forintek Canada Corp.
Eastern Laboratory
800 Montreal Road
Ottawa, Ontario
K1G 3Z5

PRINCIPAL INVESTIGATOR Dr. J.M. Kryla

DURATION August 1981 - September 1982

COST $41,900

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY Dr. Ralph Overend
Division of Energy Research & Development
Building M-50
National Research Council
Ottawa, Ontario
K1A 0R6

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$31,564			$31,564
1982-83	$10,336			$10,336

OBJECTIVE

Phase 1 To determine the relationship between particle size and calorific values of wood and bark.

Phase 2 To determine and quantify the factors responsible for the variation in calorific values with particle size.

DESCRIPTION

1. a) Homogeneous mixtures of dry hybrid poplar and eastern white spruce will be ground in a hammer-mill and/or a laboratory Wiley Mill. The material will then be separated on the basis of size.

   b) Oxygen bomb calorimetry will be utilized to determine calorific values and an evaluation on CO and water will be conducted. The gases will be analysed by gas chromatography.

   c) The effect of moisture content during comminution will also be studied.

2. a) The investigators will quantify the factors involved in particle size effect on calorific values.

   b) The content of lignin and/or hemicellulose will be determined.

   c) An elemental analysis will be done on C, H, and O and aproximate elemental analysis of fixed carbon and volatile content will be done.

   d) The ash content will also be determined.

   e) Differential scanning calorimetry (DSC) will be done on selected materials of two mesh size.

   f) Enthalpy changes and transition temperatures will be measured for more complete analysis. DSC will be used to verify the premise that less energy is required to ignite thermal degradation in smaller particles.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

242

TITLE: Evaluate Canola Oil as a Fuel for Farm Diesel Engines

CONTRACT #: 01s43-1-EL05

ORGANIZATION: Department of Agricultural Engineering
University of Saskatchewan
Saskatoon, Saskatchewan

PRINCIPAL INVESTIGATOR: R.C. Strayer

DURATION: December 1981 - December 1982

COST: $114,000

SPONSOR: Agriculture Canada

SCIENTIFIC AUTHORITY: M. Stumborg
Agriculture Canada,
Research Branch
Research Station
Swift Current, Saskatchewan
S9H 3X2
(613) 773-4621

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$25,000			$25,000
1982-83	$89,000			$89,000

OBJECTIVE

To undertake a comprehensive evaluation of the suitability of canola oils for fora diesel engines including engine wear, exhaust emission, engine performance and the developoent of oil extraction techniques from canola seeds.

DESCRIPTION

The task is to be divided among three participants.

1. The University of Saskatchewan is to conduct long tera engine tests using a two cylinder Petter and a six cylinder turbo-charged John Deere. The Petter will use a split diesel-canola fuel the the John Deere a refined canola oil. The study will examine power output, fuel consumption, viscosity and the rate of contaminant build up in the oil. The University will manage all aspects of the contract.

2. The Saskatchewan Research Council will conduct analyses of exhaust emissions of the following fuels: diesel, canola oil, 50/50 blend of canola and diesel, methyl esters of canola, 9:1 canola - ethanol blend, and high erucic type rapeseed oil. The lubrication oil will be examined after use.

3. The POS Pilot Plant Corp. will monitor the quality of oils used in engine tests and continue the evaluation of a farm-size mini-press for producing oil. POS is to also conduct a pilot plant production analysis of several esters of canola oil, including economics of production and uses of all by-products.

REPORTS

STATUS AND COMMENTS

Refer to project data sheet 172 for previous work.

PROJECT DATA

84

TITLE Development of a Process for Conversion of Wood into Liquid Fuel

CONTRACT # 0SS8.KL229-9-7053 (OS879-00017) C44

ORGANIZATION Dept. of Chemical Engineering & Applied Chemistry, University of Toronto,
200 College Street,
Toronto, Ontario. M5S 1A4

PRINCIPAL INVESTIGATOR Dr. D. Mackay (416) 978-4019
D.G.B. Boocock

DURATION 36 months

COST $110,000

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY Dr. R.P. Overend
Energy Research & Development
N.R.C.
Room 206, Bldg. M-50
Ottawa, Ontario. K1A 0R6
(613) 993-3405

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1979-80	$44,328			$44,328
1980-81	$36,880			$36,880
1981-82	$28,792			$28,792

OBJECTIVE

To design and construct a continuous reaction system of approximately 5 litres capacity capable of wood conversion at a rate of 0.2 kilograms per hour, to test the system by prolonged continuous run and to obtain data essential for the design of a large scale pilot plant operating at perhaps 100 times the capacity.

DESCRIPTION

This project is undertaken in parallel with the existing project the aim of which will continue to be to obtain fundamental data on reaction mechanisms and kinetics. A bench scale continuous unit will be constructed to evaluate the process for the direct liquefaction of wood. The unit will be operated to obtain technical information to be used in the design and construction of a pilot plant. In particular, wood residence times, temperature, pressure and catalyst recycling will be investigated.

REPORTS

Biomass Liquefaction in Canada: A Review of the Current Status. Proceedings of a workshop held at University of Toronto, August 12, 1980. Compiled and edited by D.G.B. Boocock, D. Mackay and S. Paterson, Department of Chem. Eng. and Applied Chemistry, University of Toronto.

STATUS AND COMMENTS

4.3.6.8 Biomass Conversion Technology/Oil Production. 31/3/82

PROJECT DATA

97

TITLE: Liquid Fuels and Chemicals from Aspen

CONTRACT #: 0SSS.KL229-9-7112 (OSSS79-00037) C48

ORGANIZATION: Dept. Chemistry & Chemical Engineering
University of Saskatchewan
Saskatoon, Saskatchewan.

PRINCIPAL INVESTIGATOR: Dr. R.L. Eager (306) 343-2954
Dr. J.F. Matthews (306) 343-3080
Dr. J.M. Pepper (306) 343-2950

DURATION: 3 years

COST: $148,443

SPONSOR: Environment Canada

SCIENTIFIC AUTHORITY: R.J. Neale, C.F.S.
Vincent Massey Building
Hull, Quebec. K1A 0E7
(613) 997-1682

TECHNICAL LIAISON OFFICER: Dr. J.F.G. Mackay
Forintek Canada Corporation
Western Forest Products Lab
6620 N.W. Marine Drive
Vancouver, B.C. V6T 1X2
(604) 224-3221

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1979-80	$32,407.12			$32,407.12
1980-81	$47,644.88			$47,644.88
1981-82	$68,392			$68,392

REPORTS

Study of the Conversion of Lignocellulosic (Aspen) Materials to Liquid Fuels and Chemicals by J.M. Pepper, R.L. Eager and J.F. Mathews, University of Saskatchewan, Saskatoon, Sask., March 1981. ENFOR Project C-48. (Available from ENFOR Secretariat)

OBJECTIVE

To conduct a detailed study of the conversion of aspen wood into a portable sulfur-free fuel oil as the major fraction and a variety of oxygenated chemicals (alcohols, ketones and acids) with solvent properties. The process involves the interaction of wood with carbon monoxide in the presence of a catalyst.

DESCRIPTION

The research includes an examination, using a small-scale batch apparatus, of the major process variables: temperature, reaction time, ratio of carbon monoxide to substrate, nature and amount of catalyst in an attempt to optimize the production of a combustible fuel oil and the by-product chemicals, an optimization based on an analysis of the oil with respect to yield, viscosity and heating value as well as the amount of, the nature of and the potential utilization of the by-product chemicals.

Proposed Timetable
First Year - Completion of initial study of process variables using batch reactor; Initial studies on use of recycle oil as reaction medium; Completion of separation and identification of major low-boiling components of water-soluble fraction.

Second Year - Completion of studies on use of recycle oil as reaction medium; Continuation of isolation and identification of higher-boiling water-soluble fractions; Design, construction and initial use of small-scale continuous flow reactor; Development of proposed mechanism of reaction and role of each of the cellulose, hemicellulose and lignin fractions of the wood.

Third Year - Operation of a small-scale, semi-continuous operation equipment to determine more reliable data on the kinetics of the process to be used to obtain an economic evaluation of an industrial-sized operation.

STATUS AND COMMENTS

The March 1981 report includes the following conclusions: 1) Aspen may be converted in the presence of carbon monoxide, water and sodium carbonate at elevated temperatures and pressures into oil, chemicals, carbon dioxide and hydrogen. 2) Green wood gives higher yields of oil than does dry wood. 3) Water and carbon monoxide are necessary reagents but only if Na_2CO_3 or NaOH is present. 4) Substituted phenolic components are evident in the oil. 5) The water-soluble organic chemicals include aliphatic alcohols, ketones and acids containing from one to six carbon atoms. 6) Recycling of 80 percent of an original aqueous phase with 20 percent make-up of water and Na_2CO_3 led to increased yields but no significant change in the resultant oil after six recycles.

4.3.6.8 Biomass Conversion Technology/Oil Production.

31/3/82

PROJECT DATA

197

TITLE Chemical Characterization of Wood Conversion to Liquid Fuels

CONTRACT # Strategic Grant

ORGANIZATION Department of Chemistry
University of Toronto
Toronto, Ontario
M5S 1A1

PRINCIPAL INVESTIGATOR T.T. Tidwell

DURATION 2 years

COST $39,158

SPONSOR Natural Science and Engineering Research Council of Canada (NSERC)

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$18,523			$18,523
1981-82	$20,635			$20,635

REPORTS

OBJECTIVE

The long range objective of this research program into the characterization of reaction products and mechanisms in wood conversion is to develop a comprehensive understanding of the actual products formed in these processes as a function of reaction conditions and to develop an understanding of how these processes occur. This knowledge would be applied to using rational changes in the reaction variables to optimize the conversion of wood to useable liquid fuels and organic raw materials. In the short term the goals are similar but are somewhat more modest: namely to characterize as many of the chemical products as possible and to design and execute experiments which contribute to a mechanistic understanding of the processes involved.

DESCRIPTION

Specific studies proposed include separations of the product into fractions on the basis of solubility and careful distillation at reduced pressure. Separation of individual components by vapor phase chromatography and high pressure liquid chromatography will be undertaken and the separated entities will be identified by spectroscopic means (infrared, multinuclear NMR, and mass spectrometry). Combined gas chromatography - mass spectrometry will be particularly useful in this regard for the identification of the large number of volatile components expected.

Once some preliminary indications of the chemical identities of the products have been obtained it will be appropriate to propose possible reaction pathways by which they may arise. Chemical control processes may then be devised to check the mechanistic hypotheses. For example, the effect of chemical additives such as tetralin or ethylbenzene on the product can be determined. The fate of the elements of these materials can be traced by ^{13}C, ^{2}H, or ^{3}H labelling. Studies will also be carried out on small model lignins and carbohydrates to see how they are affected by the reaction conditions. In previous experiments the pH has not been controlled and the influence of this variable can be examined.

There are indications that considerable portions of the product are phenolic, and that some of the chemical reactions involved are side chain reactions and ring substitutions of these components. Detailed spectroscopic examination of the products should be highly informative for the identification of these materials, even if pure constituents cannot be isolated.

STATUS AND COMMENTS

Work conducted in collaboration with D.G.B. Boocock, University of Toronto.

PROJECT DATA

198

TITLE Hydrogenation using Short Retention Times

CONTRACT # Strategic Grant

ORGANIZATION Génie Chimique
Sherbrooke University
Sherbrooke, Québec
J1K 2R1

PRINCIPAL INVESTIGATOR E. Chornet (819) 565-4320

DURATION 3 years

COST $119,967

SPONSOR Natural Sciences & Engineering Research Council

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$49,260			$49,260
1981-82	$60,363			$60,363
1982-83	$59,604			$59,604

OBJECTIVE

To develop the pyrolytic technique of hydrogenolysis/hydrogenation using short retention times for the production of pyroligneous oils.

DESCRIPTION

The work is to include:

1. The development of comparative studies on the influence of long and short contact times in the hydrogenolysis reaction.
2. The development of basic experimental data on the step approach to hydrogenolysis: a) selective hydrolysis followed by hydrogenation; b) pyrolysis under vacuum and hydrogenation of the liquids and solids produced.
3. A characterization of the products.
4. A microscopic examination of the complex particles during the process.
5. The role of CO and its interaction with the solvent.
6. Modifications to the catalysts.
7. The design and construction of a new reactor using the high shear, high mixing speed nozzle concept for treating biomass materials and upgrading primary products.

REPORTS

Related publications as of 1980.

Chornet E, Fonseca R., Grandbois M., and Brown R.P., "The Conversion of Peat and Humic Materials into Liquid Fuels using Carbon Monoxide", Can. J. Chem. Eng., accepted for publication, April 1980.

Kiennemann A., and Chornet E., "A Study of the Methanation Reaction using Simple Metal-Doped Peat-Derived Carbons", I & EC Product Res. Dev., accepted for publication, April 1980.

Roy C., Bellemare G.R., and Chornet E., "The Effect of Sensitivity Setting of a Katharometer on Response Factors at Low Concentrations", J. of Chromatography, accepted for publication, April 1980.

Ramusat J.F., Chornet E., "Décoloration et détoxification de Salle d'Ecorçage à l'aide d'un Charbon provenant de la pyrolyse des écorces", Water Poll, Res. Can., accepted for publication, April 1980.

STATUS AND COMMENTS

4.3.6.8 Biomass Conversion Technology/Oil Production.

23/3/82

PROJECT DATA

210

TITLE Characterization of the Pyrolytic Oils from Trembling Aspens

CONTRACT # KM107-1-4315(08581-00108) C-256

ORGANIZATION Université de Sherbrooke
2500 University Blvd.
Sherbrooke, Québec
J1K 2R1

PRINCIPAL INVESTIGATOR Dr. Christian Roy, ing., Ph. D.
Dept de génie chimique

DURATION August 1981 - June 1982

COST $35,3560

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Place Vincent Massey
Hull, Québec K1A 0E7
(613) 997-1682

TECHNICAL LIAISON OFFICER: Mr. R. Graham
Forintek Canada Corporation
Eastern Laboratory
800 Montreal Road
Ottawa, Ontario

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$30,000			$30,000
1982-83	$ 5,360			$ 5,360

OBJECTIVE

To develop a method for characterizing biomass synthetic oils that will facilitate the use of a common and reliable analytical basis for all Canadian research on these oils.

DESCRIPTION

1. The development and application of an extraction method for the characterizing of hydrogenolysis oils.
2. The development and application of another extraction method for the characterizing of pyrolytic oils.
3. The development of statistically proven procedures for determining the gases issuing from extraction processes.
4. The development of a new method for characterizing pyrolysis oils, involving distillation column chromatography, gas chromatography and liquid chromatography.

A. To develop techniques for the separation of pyrolytic oils, from Populus tremuloides, obtained by thermal decomposition under vacuum at 530°C, by high pressure liquid chromatography and gas chromatography.

B. Identification of the major and minor components of these oils.

C. Application of these techniques for the analysis of the pyrolytic oils produced from other lignocellulosics (hard woods, soft woods, bark, etc.).

D. A quantitative analysis of the major pyroligneous constituents from Populus tremuloides.

REPORTS

STATUS AND COMMENTS

4.3.6.8 Biomass Conversion Technology/Oil Production. 28/3/82

PROJECT DATA

235

TITLE Production of Oils from Wood

CONTRACT # Strategic Grant

ORGANIZATION Génie Chimique
Université de Laval
Québec, Québec

PRINCIPAL INVESTIGATOR S.C. Kaliaguine

DURATION 3 years

COST $170,279

SPONSOR Natural Sciences & Engineering Research Council

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR	EQUIPMENT	TOTAL
1981-82	$48,500		$32,779	$81,279
1982-83	$46,500			$46,500
1983-84	$42,500			$42,500

OBJECTIVE

This project includes a study of the technique of the production and the upgrading of pyrolytic oils prepared from wood. For the production we propose to employ the technique of supercritical extraction considered to be particularly promising economically, since it avoids the costs of the production and compression of the reducing gases. For the upgrading, we propose to use the catalyst ZSM-5 which enables the production of gasoline from methanol and a number of other organic compounds containing oxygen.

DESCRIPTION

The project consists of three sub-projects each with its own objective but contributing to the overall end.

Sub-Project 1: Production of pyrolytic oils by the super-critical extraction method. The aim is to study the conditions of mass transfer and also heat transfer during pyrolysis. We are interested not only on the effect of these parameters on the conversion into liquid product, but also on their effect on the conversion into gasoline obtained in the course of the standard ZSM-5 process.

Sub-Project 2: The study of the conversion of the pyrolytic oils on ZSM-5. The object will be to determine the optimum conditions of the catalytic procedure for the production of gasoline in the absence of all additional reactants by using a pulse reactor. By using the oils produced in sub-project 1 as reactants in sub-project 2, allows the simultaneous optimization of the two procedures, the production of the oils and their upgrading.

Sub-Project 3: The study of the conditions for the synthesis of zeolite ZSM-5 and the catalysts obtained by depositing different metals in the zeolite. The properties of the catalysts thus obtained, will also be studied by examining the reaction of the major constituents such as phenol, pyrogallol, and levoglucosan with CO and the mixture of CO and H_2 under pressure. The object is to investigate the catalysts which can be used to produce the reaction in sub-project 2 (mainly a dehydration) and at the same time with the reaction of gas to water in order to eliminate oxygen which entres the oil in the form of CO_2

REPORTS

Related publications as of 1981.

Vijayan C.P., Ghaly E., Kaliaguine S., Galibois A., "Moisture Evacuation During Compressed Natural Gas Discharge". Submitted for publication.

Kaliaguine S., Gnakoury M., Roberge P.C., "Propriétés photocatalytiques de Ta_2O_5/SiO_2". Accepted for publication, Can. J. Chem. Eng.

Kaliaguine S., Ramalho, R.S., and Le Bach B., "Excess enthalpies of binary gaseous system C_2H_4-CO_2". Can. J. Chem. Eng. 57, 363 (1979).

STATUS AND COMMENTS

4.3.6.8 Biomass Conversion Technology/Oil Production.

28/3/82

PROJECT DATA

71

TITLE Supercritical Gas Extraction of Chemicals from Forest Products

CONTRACT # KL229-9-7045 C51

ORGANIZATION Division of Applied Chemistry, B.C. Research, 3650 Wesbrook Mall, Vancouver, B.C. V6S 2L2

PRINCIPAL INVESTIGATOR Dr. John Howard (604) 224-4331

DURATION 36 months

COST $180,980

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale, C.F.S.
Vincent Massey Building
Hull, Quebec. K1A 0E7
(613) 997-1682

TECHNICAL LIAISON OFFICER: Dr. J.F.G. Mackay
Forintek Canada Corporation
Western Laboratory
6620 N.W. Marine drive
Vancouver, B.C. V6T 1X2
(604) 224-3221

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1979-80	$72,600			$72,600
1980-81	$83,480			$83,480
1981-82	$97,500			$97,500

REPORTS

1. Supercritical Gas Extraction of Chemicals from Forest Products, John Howard, March 1980 - An interim report. (Available from ENFOR Secretariat or Energy Library, CISTI)
2. Supercritical Gas Extraction of Chemicals from Forest Products, Phase II, Elizabeth C. McDonald, John Howard, October 1981. An interim report. (Available from ENFOR Secretariat or Energy Library, CISTI)

ABSTRACT: Liquid products containing over 90% of the carbon content of wood were isolated following extraction of green sawdusts using supercritical methanol and supercritical acetone.

Methanol at 360°C or acetone at 300°C and 27.6 MPa gave weight yields in excess of 70%, based upon dry western red cedar wood, of dark viscous products. Pretreatment of the wood with strong acid gave similar yields at lower extraction temperatures and pressures.

An economic analysis based on laboratory experiments indicated that product cost could be $21 a barrel, excluding land and wood costs.

OBJECTIVE

To attempt the extraction of essential oils, naval stores and lignins from forest products using gases at very high pressures at just above their critical temperatures and by such means save energy relative to the more conventional methods of extraction and also to maximize yield and minimize decomposition often associated with such methods.

DESCRIPTION

Forest product substrates will be contacted with various gases at very high pressures and at temperatures slightly above their critical points. The gases chosen for extraction will be those which are thought to show the most affinity for the desired extract. Thus polar gases are more likely to have a greater positive effect on the vapour pressure of a polar extractive than a non polar gas. The "solubilized" extractives will be recovered from the gas phase upon release of the pressure in a separate chamber. Equipment design will be based to some extent upon experience gained in the supercritical gas extraction of coal.

First a literature search will be carried out to determine whether supercritical gas extraction has received attention in the isolation of or modification of forest product chemicals. Next a laboratory investigation will be carried out on the extraction of non polar essential oils from foliage via supercritical gas extraction, retaining the residues for possible consideration as animal feeds. Thirdly the relatively non polar volatile oils including turpentine, fatty and resin acids (naval stores) and steroids from fresh wood will be extracted using gases at high pressures limiting the wood species chosen for the study to those of commercial importance in western Canada. Next the polar lignin extractives occuring in wood and bark will be examined, which materials, because of their relative- ly low volatility and frequent chemical instability, will represent the greatest challenge to supercritical gas extraction.

STATUS AND COMMENTS

PROJECT DATA

179

TITLE Development of lignin adhesives

CONTRACT # KL229-1-4119(OSS81-00074) C-209

ORGANIZATION Forintek Canada Corp.
Eastern Laboratory
800 Montreal Road
Ottawa, Ontario
K1G 3Z5

PRINCIPAL INVESTIGATOR Louis Calvé

DURATION July 1981 - March 1982

COST $85,338

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY Dr. V.N.P. Mathur
Canadian Forestry Service
Environment Canada
19th Floor, Place Vincent Massey
Hull, Québec
K1A 1G5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$85,338			$85,338

REPORTS

OBJECTIVE

1. To develop lignin adhesives into a commercially acceptable product replacing phenol formaldehyde (PF) in waferboard and plywood applications.
2. To optimize the binding properties of the lignin - PF resins with respect to lignin type.
3. To study the effect of addition of acid catalyst on the rate of curing the lignin - PF resin.
4. To study the effect of lignin methylation on the curing rate of the lignin - PF resin.
5. To optimize the binding properties of the lignin phenolic resins with respect to phenolic resin type.
6. For both plywood and waferboard manufacture, adjust PF, resin to lignin ratio and pressing conditions.

DESCRIPTION

Lignin can be obtained from the Iotech process in several different forms, by extraction with various solvents or as a residue after enzymatic hydrolysis.

Phase 1 With a view to further investigating the potential of the Iotech lignin as a binder, the following Iotech lignins will be evaluated for both plywood and waferboard application:

- crude enzymatically extracted lignin containing cellulose impurities
- alkali-extracted, enzymatic Iotech lignin which would contain the full lignin fraction without insoluble cellulose impurities
- high molecular weight alkali-extracted Iotech lignin (50%).
- low molecular weight alkali-extracted lignin (50%).

The different Iotech lignins will be used to prepare different lignin - PF resins. Each resin will be evaluated for plywood and waferboard application.

Phase 2 A PF resin which will provide a lignin - PF resin with the best physical and chemical properties will be selected and the selected lignin - PF combination will be optimized.

STATUS AND COMMENTS

Sub-contract to Iotech Corporation for the preparation of lignin types is complete.

At Forintek tests are continuing on resins prepared from Iotech lignins for plywood veneer and waferboard production.

PROJECT DATA 36

TITLE Energy from Renewable Agricultural Waste and other Biomass

CONTRACT # 15SQ.23440-8-9041, SP4
15SQ.23380-0-6505

ORGANIZATION Saskatchewan Power Corporation
Research and Development Centre
2025 Victoria Ave., Regina, Sask. S4P 0S1

PRINCIPAL INVESTIGATOR Dr. S. Van Der Heijden

DURATION September 1, 1978 to March 31, 1982

COST Contract 1 - $137,512
Contract 2 - $ 55,565

SPONSOR Energy, Mines and Resources

SCIENTIFIC AUTHORITY Dr. G. Sirianni
Energy, Mines and Resources
555 Booth Street
Ottawa, Ontario. K1A 0G1
(613) 996-4570

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1978-79	$57,450			$57,450
1979-80	$30,017			$30,017
1980-81	$50,045			$50,045
1981-82	$51,565			$51,565

REPORTS

"Feasibility, Operability and Economic Studies for Energy Sources from Renewable Agricultural Waste and Other Biomass - Interim Report", by Saskatchewan Power Corporation, June 1980.

Final reports expected on both contracts.

OBJECTIVE

To evaluate the feasibility, operability and economics of fuel gas and electrical power generation from a continuous portable biomass gasifier - motor-generator set.

DESCRIPTION

In Western Canada, there are a number of very small communities that have 10 - 20 customers in isolated locations which are currently dependent on fuel oil or propane gas for space heating, and diesel engines for power generation. These communities are often located near forest resources which are a renewable source of energy.

Gas produced from forest biomass will be tested as a substitute energy source for electrical generation in remote communities.

Contract I - A 78 kw continuous feed Imbert gasifier was procured and it will be mounted on a portable platform and commissioned.

Extensive laboratory testing will be conducted based on electrical systems principals, such as load planning and load characteristics for small isolated communities of 10 - 20 customers.

Contract II - Long-term field testing of the Imbert plant in a remote community in northern Saskatchewan. Sites under consideration are commercial communities, such as fishing camps, logging camps, etc. where the electric peak demand does not exceed 65 kw.

STATUS AND COMMENTS

Issued as 2 contracts.

Work is complete.

PROJECT DATA

140

TITLE High Intensity Pyrolysis of Biomass

CONTRACT # KL229-0-4118 (OSS80-90) C-147

ORGANIZATION University of Western Ontario
Department of Chemical Engineering
London, Ontario. N6A 5B9

PRINCIPAL INVESTIGATOR M.A. Bergougnou (519) 679-3326

DURATION April 1980 - October 1982

COST $184,559

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY Dr. R.P. Overend
National Research Council
Building M-50
Ottawa, Ontario
K1A 0R6

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$ 51,380			$ 51,380
1981-82	$133,179			$133,179

OBJECTIVE

1. Development at the bench level of a versatile process for the co-production of ethylene, reactive chemical intermediates, synthesis gas, enriched fuel gas and power by high intensity pyrolysis of biomass.
2. Design and build a new reactor for the study of kinetics and product yield structure of the above process.
3. Feasibility design of a commercial plant based on the above.
4. Design of a pilot plant and stake-out of the pilot plant program.

DESCRIPTION

High intensity pyrolysis is characterized by 1) extremely fast feed heat-up rates 2) ultra-short and uniform residence time at high temperatures 3) very rapid quench of products. The proposed reactor will meet the above criteria by 1) very fast mixing of hot heat carrier with fresh ground wood 2) passing the mixture downflow in dilute phase form in a tubular reactor for a very short and controlled time 3) Quenching the reactor products with cold solids. The effect of major process variables will be studied: temperature, pressure, residence times, steam and hydrogen treat rates. Various woods and wood components, e.g. lignin, cellulose, will be used.

REPORTS

STATUS AND COMMENTS

4.3.6.11 Biomass Conversion Technology/Pyrolysis.

31/3/82

PROJECT DATA 184

TITLE Continuous flash pyrolysis of wood

CONTRACT # KL229-1-4122(OSS81-00004) C-223

ORGANIZATION University of Waterloo
Waterloo, Ontario
N2L 3G1

PRINCIPAL INVESTIGATOR Dr. D.S. Scott
Dept. of Chemical Engineering

DURATION April 1981 - April 1983

COST $213,515

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Place Vincent Massey
Hull, Québec K1A 0E7
(613) 997-1682

TECHNICAL LIAISON OFFICER: R.G. Graham
Forintek Canada Corporation
Eastern Laboratory
800 Montreal Road
Ottawa, Ontario

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$133,139			$113,139
1982-83	$100,376			$100,376

OBJECTIVE

To design, construct and test equipment for continuous flash pyrolysis of wood.

DESCRIPTION

1. Construction of a cold flow unit of glass and acrylic, testing of circulation loops in cold flow.
2. Design and construction of a 1kg/h continuous flash pyrolysis unit.
3. Determination of optimal yields and conditions, including tests with and without catalysts, using aspen poplar.
4. Further tests on one or two additional softwoods, bark twigs etc. at near optimal conditions.
5. Combustion tests, characterization of products.

REPORTS

STATUS AND COMMENTS

4.3.6.11 Biomass Conversion Technology/Pyrolysis. 23/3/82

PROJECT DATA

238

TITLE Saccharification of Biomass by Reduced Pressure Pyrolysis Followed by Hydrolysis

CONTRACT # Strategic Grant

ORGANIZATION Département de génie chimique
Université de Sherbrooke
Sherbrooke, Québec

PRINCIPAL INVESTIGATOR C. Roy

DURATION 3 years

COST $116,500

SPONSOR Natural Sciences and Engineering Research Council

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR	EQUIPMENT	TOTAL
1981-82	$36,000		$8,500	$44,500
1982-83	$36,000			$36,000
1983-84	$36,000			$36,000

OBJECTIVE

To undertake pyrolytic saccharification of wood for the production of ethanol.

U.S. studies on pure cellulose have indicated that pyrolysis under reduced pressure produces material that is readily hydrolysed. It is proposed to investigate the conversion of different lignocellulosics.

DESCRIPTION

The overall approach will be the pyrolytic conversion of different lignocellulosics under reduced pressure. The pyroligneous material will at the same time be characterized and acid hydrolysed to determine its suitability as a feedstock for ethanol production.

Short term: To produce samples of pyroligneous material from diverse lignocellulosics (hardwood, soft wood , wheat straw, oat straw, corn stover, bark) in order to treat them by acid hydrolysis (batch). Catalysts will be tested to increase yields or to suitably modify the pyroligneous material (ex. Co^{+2}, Fe^{2+}, Ni^{+2}).
To develop analytical techniques for the identification and quantification of the sugars.
To develop a technique for characterizing the secondary products.

Long term: If the batch hydrolysis tests prove promising further development will be undertaken.
To determine the fermentability of the hydrolysate and to investigate any microbial inhibitors in the hydrolysate. If inhibitors are present the sugars would be isolated or purified. Preliminary fermentation would be carried out by either conventional yeasts or by bacteria adapted to pentoses and hexoses.

REPORTS

Related publications as of 1981.

Roy C., "Etude de la décomposition thermique sous vide de la tourbe en présence d'additifs métalliques et modèle cinétique de la formation des gaz pyrolytiques", Thèse de doctorat, Faculté des sciences appliquées, Université de Sherbrooke, décembre 1980.

Chornet E., et Roy C., "Vacuum pyrolysis of lignocellulosic materials", Demande de brevet canadien, No. d'enr. 1041132. Déposé le 18 décembre 1980.

Chornet E., et Roy C., "Vacuum pyrolysis of lignocellulosic materials. Demande de brevet aux Etats Unis. (Pas encore enregistré). Déposé en décembre 1980.

Roy C. Chornet E., Ménard H. de Caumia B. Chauvette G., et Gaboury A., "Pyrolyse à pression réduite de matière lignocellulosiques et caractérisation des huiles pyrolytiques. Proceedings of the 3rd Bioenergy R&D Seminar, Ottawa, March 24-25 1981.

STATUS AND COMMENTS

Working in collaboration with H. Ménard, E. Chornet and, B.P. Cayrol.

4.3.6.11 Biomass Conversion Technology/Pyrolysis. 23/3/82

FUNDAMENTAL STUDIES

PROJECT DATA

61

TITLE: Anaerobic conversion of cellulose to metha

CONTRACT #

ORGANIZATION: National Research Council
100 Sussex Drive
Ottawa, Ontario. K1A 0R6

PRINCIPAL INVESTIGATOR: Dr. S.M. Martin 992-2367

DURATION: 1 April 1978 - continuing

COST: $1,216,000

SPONSOR: Biological Sciences and Bioenergy Program, NRC.

SCIENTIFIC AUTHORITY: Dr. S.M. Martin
Biological Sciences
Sussex Drive
Ottawa, Ontario. K1A 0R6
(613) 992-2367

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1978-79	$296,000			$296,000
1979-80	$368,000			$368,000
1981-82	$268,300			$268,300
1982-83	$283,700			$283,700

OBJECTIVE

To examine in detail the biochemical and microbiological aspects of the anaerobic conversion of cellulosics to fuels and energy intensive feedstock.

DESCRIPTION

An application-oriented study of the conversion of cellulosic materials to methane, hydrogen, and ethanol by anaerobic bacteria.

The generation of fuels from cellulose via the fermentation route is a complex process involving a number of degradative and synthetic steps carried out by quite different groups of micro-organisms. To fully understand the process it is necessary to examine the elements of the system in isolation and together. The programme involves:

1. establishment of in vitro anaerobic ecosystem capable of degrading cellulosics (cellulose, ligno-cellulose and hemicellulose) to methane;
2. study of the physiology of a new organism, Acetivibrio cellulolyticus, recently isolated from such an ecosystem; this organism is characterized by its ability to degrade cellulose to hydrogen, carbon dioxide and acetic acid;
3. isolation and characterization of the cellulase complex produced by A. cellulolyticus and examination of the potential of the organism for the production of industrially useful amounts of cellulase;
4. cloning of the genes governing the degradation of cellulose using recombinant DNA techniques, with the view to enhancing cellulase production;
5. study of a co-culture system established between A. cellulolyticus/Desulfovibrio/Methanosarcina barkeri with the aim of understanding the symbiotic involvement of various organisms in the conversion of cellulosic biomass to methane;
6. isolation, characterization and nutritional requirements of fastidious anaerobes;
7. study of the intermediary metabolism of methanogenic bacteria.

REPORTS

1. Cellulase production by Acetivibrio cellulolyticus, Saddler J.N. and Khan A.W., Can. J. Microbiol. 26: 760-765.

2. Composition of Methanospirillum hungatii GP1 during growth on different media, Breuil C. and Patel G.B., Can. J. Microbiol. 26: 577-582. NRCC No. 18121.(1980)

3. Degradation of cellulose by a newly isolated Mesophilic Anaerobe, Bacteriodacese family, Khan W.W., Saddler J.N., Patel G.B., Colvin J.R. and Martin S.M., FEMS Microbiology Letters 7 (1980) 47-50. NRCC # 17871.

4. Viability and depletion of cell constituents of Methanospirillum hungatii GP1 during starvation, Breuil C., and Patel G.B., Can. J. Microbial. 26: 887-892. NRCC No. 18352. (1980)

STATUS AND COMMENTS

The coculture Acetivibrio cellulolyticus/Desulfovibrio/Methanosarcina barkeri converts cellulose to CH_4 and CO_2 with no net acetate, ethanol or H_2 accumulation. Acetate utilization rather than substrate solubilization is the rate limiting step. The role of Desulfovibrio seems to be the conversion of ethanol to acetate rather than to supply additional H_2S.

Operational parameters are being derived for the conversion of cellulose to ethanol, acetate, H_2 and CO_2 by A. cellulolyticus. Studies have shown that steam exploded wood is rapidly utilized after lignin removal and that the cellulases are relatively acid stable under "use" conditions.

4.3.7.1 Bioenergy Fundamental Studies/Anaerobic Fermentation. 31/3/82

PROJECT DATA

209

TITLE: Anaerobic Fermentation of Cellulose

CONTRACT #

ORGANIZATION: Rideau Falls Laboratory
Biological Sciences
National Research Council
Sussex Drive
Ottawa, Ontario

PRINCIPAL INVESTIGATOR: A.W. Khan, Ph.D.
W.D. Murray, Ph.D.

DURATION: On-going from April 1980

COST: $300,000

SPONSOR: National Research Council

SCIENTIFIC AUTHORITY: N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$ 60,000			$ 60,000
1981-82	$100,000			$100,000
1982-83	$140,000			$140,000

OBJECTIVE

To understand the process of anaerobic degradation of cellulose and other biopolymers from the microbiological and biochemical point of view, and to utilize this knowledge (a) to improve the conversion of cellulose to methane, (b) to further exploit this process for the production of fuels, energy and chemical feed stock and (c) to determine the conditions for efficient conversion of cellulose in continuous or semi-continuous reactors.

DESCRIPTION

Work is being done to understand the microbial ecosystem and to develop fermentation techniques for improving the degradation of insoluble biomass such as cellulose and municipal solid waste. Efforts to develop more effective cultures involve the study of various microorganisms present in enrichment cultures and their isolation in pure culture, as well as their substrace metabolism and symbiotic relationships. The fermentation conditions are being studied using both stationary and continuous culture techniques with 2 to 30 L fermenters. A single-step mesophilic process for the conversion of cellulose and hemicellulose to ethanol is under development.

REPORTS

1. Clostridium saccharolyticum sp.nov., a Saccharolytic species from Sewage Sludge by W.D. Murray, A.W. Khan and L. van den Berg, Intern. J. System. Bacteriology, 32, 132-5 (1982). NRCC # 19895.

2. Regulation of cellulase synthesis in Acetivibrio cellulolyticus by J.N. Saddler, A.W. Khan and S.M. Martin, Microbiose, 1980, 28, 97-106. Issued by NRCC 18740. (Available from the author).

3. Cellulolytic Enzyme System of Acetivibrio cellulolyticus by J.N. Saddler and A.W. Khan. Canadian Journal of Microbiology 1981, 27, 288-294. Issued by NRCC # 19016. (Available from the author).

STATUS AND COMMENTS

4.3.7.1 Bioenergy Fundamental Studies/Anaerobic Fermentation.

23/3/82

PROJECT DATA

116

TITLE Fermentation of Pentoses by Yeasts

CONTRACT #

ORGANIZATION Molecular Genetic Group
Division of Biological Sciences
100 Sussex Drive
National Research Council

PRINCIPAL INVESTIGATOR H. Schneider

DURATION 1979 - 1983

COST $149,062

SPONSOR Bioenergy Program and the Division of Biological Sciences

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR BIOENERGY	CONTRACTOR	BIO-SCI	TOTAL
1979-80	$20,262			$20,262
1980-81	$30,993		$12,500	$43,490
1981-82	$72,331		$13,000	$85,310

REPORTS

Pentose Fermentation by Yeasts, H. Schneider, P.Y. Wang, B.F. Johnson and C. Shapeis. Curr. Dev. Yeast Res., Adv. in Biotech. G.C. Stewart and I. Russell, eds. (1981) pp 81-85, NRCC 18461.

Conversion of D-xylose into Ethanol by the Yeast Pachysolen tannophilus, H. Schneider, P.Y. Wang, Y.K. Chan and R. Maleszka, Biotech. Lett. 3, 89-92 (1981), NRCC 19095.

Growth of Yeasts on D-xylose, P.Y. Wang, and H. Schneider, Can. J. Microbiol. 26, 1165-1168, (1980), NRCC 18463.

Fermentation of D-xylose by Yeasts Using Glucose Isomerase in the Medium to Convert D-xylose to D-xylulose, P.Y. Wang, B.F. Johnson and H. Schneider, Biotechnol. Lett. 2, 273-278 (1980), NRCC 18377.

OBJECTIVE

To obtain yeasts that can efficiently convert pentoses as well as hexoses into ethanol in order to increase alcohol yields in the fermentation of biomass sugars.

DESCRIPTION

Two approaches are being used. One centers on the study of some naturally occuring yeasts and their mutants which are able to convert the pentose D-xylose into ethyl alcohol. These studies are specifically aimed at producing orgnisms suitable for industrial use. They involve investigation of conditions for optimum ethanol yeild and of the associated relevant biochemistry and genetics. The other approach centers on the use of genetic engineering methods. The objective is to transfer into a yeast host, which is presently used industrially but which does not convert pentoses to ethanol, genes from other organisms which would allow the conversion to take place.

STATUS AND COMMENTS

At the bench top level, the problem of converting D-xylose into ethanol has been solved. With a mutant of a naturally occuring xylose fermenter, Pachysolen tannophilus, yields exceeding 90% of theoretical were obtained from a mixture of sugars similar to that encountered in commercial practice. The yield quoted is that for alcohol from the hexoses as well as the D-xylose present in the mixture. The key problem remaining is to get a yeast that can perform similarly under the conditions expected in commercial practice.

Progress has also been made using the genetic engineering approach by identification of the gene required (D-xylose isomerase), and by its successful cloning in a bacterium. Subsequent steps require transfer of this gene to a suitable yeast host, and its expression at a high level.

It is still too early to determine which of the approaches will lead more quickly to industrially useful strains.

PROJECT DATA

122

TITLE The Construction of Microbial Strains for Energy Production

CONTRACT #

ORGANIZATION Molecular Genetics
Biological Sciences
National Research Council
Ottawa, Ontario. K1A 0R6

PRINCIPAL INVESTIGATOR A. James
(613) 992-7833

DURATION 1979 - continuing

COST $350,000 to date

SPONSOR Bioenergy Program and Division of Biological Sciences of NRC

SCIENTIFIC AUTHORITY

FUNDING

FISCAL YEAR	ENERGY SPONSOR	CONTRACTOR	BIOLOGY	TOTAL
1979-80	$10,000			$ 10,000
1980-81	$10,000		$130,000	$140,000
1981-82	$ 8,500		$192,000	$200,500

REPORTS

OBJECTIVE

1. To provide a continuous watching brief that summarizes those recent findings, new techniques, and current trends in basic and applied genetic engineering that bear on the more efficient utilization of biomass in energy production.

2. To expand fundamental research on the expression, in yeast, of genes from other fungi.

DESCRIPTION

1. To conduct an extensive survey of literature dealing with recombinant DNA techniques in the utilization of biomass for energy production. To attend national and international conferences concerned with the role of biotechnology in energy production. To provide NRC's Division of Energy with a continuous watching brief concerned with trends and advances in this area.

2. The aim of this program is to use recombinant-DNA technology to extend the range of carbohydrate substrates that yeast can ferment to ethanol. At present the Molecular Genetics Group at NRC is engaged in a PILP-funded collaboration with industry (BioLogicals Inc.) on the development of a yeast that can directly ferment crystalline starch to alcohol. The group is also participating with the Ontario Paper Company supported by PILP funds for the development of strains of yeast that can utilize cellulose.

These projects are being carried out as part of an exploratory investigation of the usefulness of recombinant-DNA techniques in Biotechnology. Research is concerned, in particular, with the genetic engineering of yeast for more efficient utilization of biomass as a source of renewable energy.

Methods for transferring genes into yeast from other species or genera are now well established. However, the molecular basis of gene expression in yeast and other higher organisms is less well understood than in E. coli. The study of gene expression in yeast will emphasize genetic methods to increase specific enzyme synthesis and excretion by this organism. The enzymes of interest are amylase, B-glucosidase, exocellulases and endocellulases. This work complements and extends the collaborative projects with industry.

STATUS AND COMMENTS

PROJECT DATA

201

TITLE Cloning of Bacterial Cellulase Genes

CONTRACT # Strategic Grant

ORGANIZATION Microbiology Department
University of British Columbia
Vancouver, B.C.

PRINCIPAL INVESTIGATOR R.C. Miller

DURATION 2 years

COST $126,840

SPONSOR Natural Sciences & Engineering Research Council

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$60,000			$60,000
1981-82	$66,840			$66,840

OBJECTIVE

The objective is to use the recombinant DNA technique to construct strains of E. coli which will make high levels of cellulase.

DESCRIPTION

1. Enrichment cultures will be used to isolate various microorganisms which will degrade efficiently the cellulose in lignocellulosic material. Both cellulose and sawdust will be used as carbon sources in the selective medium

2. Promising clones will be purified and assayed quantitatively for their capacity to saccharify cellulose and lignocellulose. Organisms showing a good capacity for cellulose saccharification will be examined for the enzymes they use to degrade lignin and cellulose.

3. Soil samples will be obtained from locations in the Lower Mainland known to have been heavily infiltrated with sawdust e.g., the ground around lumber yards, areas containing sawdust fill, and so on. Enrichment cultures, both aerobic and anaerobic, will be set up with sawdust or purified cellulose and the soil samples. Isolates obtained by enrichment will be screened for their growth characteristics; the rates at which they degrade cellulose and sawdust; the extent of substrate degradation; the nature of the enzymes used for degradation; the stabilities of the enzymes.

4. The most active strains will be examined for the production of cell-bound, and free enzymes, and for the three types of activity involved in cellulose saccharification.

5. If a suitable system can be developed, we will attempt to clone some of the enzymes involved in an attempt to improve the efficiency of the system. We will initiate construction, isolation and characterization of strains of E. coli which carry cellulase genes on plasmids. The objective will be to obtain strains which export cellulases in large amounts.

REPORTS

Related publications as of 1980.

Dunn R., Delaney A.D., Gillam I.C., Hayashi S., Tener, G.M., Grigliatti T., Misra V, Spurr M.G., Taylor D.M., and Miller R.C., Jr., "Isolation and characterization of recombinant plasmids carrying Drosophila tRNA genes", Gene 7: 197-215 (1979).

Burck K., Scraba D, and Miller R.C., Jr. "An electron microscopic analysis of partically replicated DNA", J. Virology (Nov.) J. Virol. 32: 606-613 (1979).

Loewen R.R., Miller R.C., Jr., and Warren R.A.J., "Mixed bacteriophage infection of Escherichia coli: exclusion of superinfecting T4 by T7" Can. J. Micro. 25: 867-873 (1979).

Burck K., and Miller R.C., Jr., "Marker rescue and partial replication of bacteriophage T7+ DNA", Proc. Natl. Acad. Sci. USA 75: 6144-6148 (1978).

STATUS AND COMMENTS

The group has produced a clone with the cellulase gene and has achieved expression of that gene (personal communication). A patent has been applied for.

Bioenergy program 15/1/82

Work being carried out in collaboration with D.G. Kilburn and R.A.J. Warren.

PROJECT DATA

249

TITLE Development of an Amylase Producing Yeast

CONTRACT # 31155-9-0623 (OSX80-00027) PILP

ORGANIZATION ENS BIO Logicals
20 Victoria Street
Suite 405
Toronto, Ontario M5C 2N8

PRINCIPAL INVESTIGATOR P. Duck

DURATION June 1980 - June 1983

COST $1,154,665

SPONSOR National Research Council - PILP

SCIENTIFIC AUTHORITY J. Vose
National Research Council
Room 310, Building M-58
Ottawa, Ontario
K1A 0R6
(613) 993-0357

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$298,200			$298,200
1981-82	$352,100			$352,100
1982-83	$410,700			$410,700
1983-84	$ 93,665			$ 93,664

OBJECTIVE

To develop an amylase producing fermentation yeast.

DESCRIPTION

Task 1 The identification of suitable amylases and selection of specific strains for donor gene. The development of yeast cloning methods.

Task 2 The isolation of the donor gene, its amplification and insertion into host organism.

Task 3 Measure gene expression, and test for stability, growth and conversion efficiency to ethanol.

Task 4 Optimization of process, secondary strain selection and modification. Selection of final strain and pilot scale growth trials.

Task 5 "Beer" distillation optimization and pilot scale optimization. Large scale trials and commercial assessment.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

250

TITLE To Produce New Strains of Yeast via Genetic Engineering for Direct Conversion of Cellulose to Alcohol

CONTRACT # 31155-9-0642 (OSX80-00083)

ORGANIZATION The Ontario Paper Company Ltd.
80 King Street
P.O. Box 3026
Ste. Catherines, Ontario L2R 7G2

PRINCIPAL INVESTIGATOR R.H. Bryant

DURATION November 1980 - November 1983

COST $1,072,452

SPONSOR National Research Council - PILP

SCIENTIFIC AUTHORITY J. Vose
National Research Council
Ottawa, Ontario
K1A OR6
(613) 993-0357

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$ 68,621			$ 68,621
1981-82	$286,669			$286,669
1982-83	$391,867			$391,867
1983-84	$325,295			$325,295

REPORTS

OBJECTIVE

To produce new engineered yeast clones capable of converting cellulose into ethanol directly.

DESCRIPTION

To develop a commercial enzyme, the work must address the following tasks:

1. Analyse sugar content (mono and oligosaccharides - hexoses and pentoses) in spent sulphite liquor.
2. Select donor strains.
3. Prepare a pure enzyme.
4. Develop enzyme sequencing.
5. Isolate DNA from donors.
6. Isolate m RNA.
7. Develop yeast vectors.
8. Establish a clone bank.
9. Prepare and purify an antibody.
10. Establish a screening method.
11. Produce cDNA.
12. Test the effects of spent sulphite liquor on the enzyme system.
13. Test the effects of yeast on the activity and stability of the enzymes.
14. Screen the clone banks.
15. Carry out the charting of gene products.
16. Construct the vector hybrids with genes.
17. Transform genes into yeast.
18. Develop multiple transformants.
19. Carry out studies for the improvement and testing of transformants.
20. Carry out labortory fermentation and transformation trials.
21. Carry out organizational and sequential analysis of cloned genes.
22. Assay sugar and ethanol with spent sulphite liquor.
23. Prepare pilot plant feed yeasts (500 lbs).
24. Carry out pilot plant trials.
25. Assess commercial viability and prepare a report.
26. Prepare and submit a comprehensive final report.

STATUS AND COMMENTS

Two proteins showing Avicelase activities have been isolated from S. commune. Their molecular weights are 65,000 and 68,000. They are both acidic proteins and have blocked N-amino terminals. Since most of the proteins of S. commune seem to be glycosylated, binding experiments using compounds having affinities for sugars are being attempted to elucidate the processing of the differenc extracellular proteins of the fungus. A clone derived from transformation experiments with S. commune DNA has given positive response when hybridized to cDNA from enriched cellulose-grown cells. This clone has to be ivestigated further.

PROJECT DATA 117

TITLE Membrane Application in Gas and Liquid Separations

CONTRACT # N/A

ORGANIZATION National Research Council of Canada
Division of Chemistry
Montreal Road,
Ottawa, Ontario. K1A OR6

PRINCIPAL INVESTIGATOR Dr. S. Sourirajan
(613) 993-2455

DURATION Oct. 1, 1979 - continuing

COST $69,510 to date

SPONSOR Bioenergy Program & Division of Chemistry, N.R.C.

SCIENTIFIC AUTHORITY Dr. S. Sourirajan
National Research Council
800 Montreal Road
Building M-12
Room 142
Ottawa, Ontario
K1A OR6

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR	DIVISION	TOTAL
1979-80	$18,510		$ 5,000	$23,510
1980-81	$51,000		$15,000	$66,000
1981-82	$51,000		$25,000	$76,000

REPORTS

OBJECTIVE

1. To produce high purity hydrogen, high Btu pipeline fuel and/or synthesis gas from gas mixtures arising in coal, petroleum and biomass conversion processes.
2. To recover alcohol in high concentrations from fermentation liquids.
3. To fractionate mixtures of organic liquids arising in petroleum processes.

DESCRIPTION

Experimental techniques for freeze-drying reverse osmosis membranes, and measuring permeability of gases have been established. A mathematical equation applicable for the analysis of experimental gas permeation data has been developed in terms of Knudsen, slip, viscous and sorbed flow through membrane pores. The utility of the above equation for predicting single- and mixed-gas transport through membranes is being investigated.

Using membranes made from a poly ether imine sulfoneurethane material, reverse osmosis separations of ethyl alcohol up to 79% have been accomplished from 10 wt.% ethyl alcohol-water feed solutions at 1000 psig. Using appropriate liquid chromatography data, the magnitudes of the interaction forces between alcohol and membrane material, and also the average pore sizes required for achieving different levels of ethanol separation in reverse osmosis are being estimated for different membrane materials.

Reverse osmosis separations of several inorganic and organic solutes in methanol solutions have been studied using cellulose acetate membranes. From liquid chromatography and reverse osmosis experiments, quantitative data on the interaction forces prevailing at the membrane material-methanol solution interfaces have been estimated. These data offer a physicochemical basis for reverse osmosis process design for the purification of industrial methanol. Further, fractionation of heptane-ethyl alcohol mixtures by permeation through cellulosic membranes is being investigated.

STATUS AND COMMENTS

Work is continuing in 1982-83. B. Summers March 1982

PROJECT DATA 108

TITLE Biochemical production of hydrogen gas

CONTRACT # Strategic Grant

ORGANIZATION Department of Chemical Engineering, McGill University, Montreal, PQ. H3A 2A7

PRINCIPAL INVESTIGATOR B. Volesky, (514) 392-5435

DURATION November 1979 - November 1982

COST $47,189

SPONSOR Natural Sciences and Engineering Research Council, Montreal Road Ottawa, Ontario, K1A OR6

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1979-80	$14,800			$14,800
1980-81	$16,360			$16,360
1981-82	$17,489			$17,489

REPORTS

OBJECTIVE

To apply contemporary fermentation techniques coupled with high efficiency solvent recovery technology to the production of industrial solvents (acetone, butanol) from renewable resources or industrial effluent streams. To optimize this process for biochemical hydrogen gas production.

DESCRIPTION

This work on hydrogen gas bio-production is complimentary to contract work being carried out on the investigation and improvement of the anaerobic solvent production biological process. Renewable resources are examined as raw materials for conversion of abundant complex polysaccharides into simple fermentable sugars which are easily converted into industrial solvents and other valuable products derived from fermentation processes. Waste and dilute carbohydrates can be converted by conventionally used strains of anaerobic bacteria, e.g. Clostridium acetobutylicum into a mixture of acetone and butanol in aqueous solution. As a by-product of the anaerobic process a mixture of CO_2 and H_2 is given off. The balance between the solvent production and gas evolution is a delicate one and depends on many key process parameters. Optimization of the process can be attempted with regard to these parameters resulting in optimal production and composition of the desired end product. A certain limitation is represented by the feedback inhibition of the process by accumulating metabolic products in a conventional batch process. To circumvent this limitation and to increase overall efficiency of the process, techniques of continuous solvent withdrawal and simultaneous raw material addition will be applied while the process bio-catalyst is maintained at its peak efficiency.

The sequence of the work will be:

1) Background review and literature research.
2) Investigation of raw materials (substrates).
3) Selection of high production microbial strains.
4) Experimental laboratory-scale tests.
5) Development of a computer model and optimization strategy.

STATUS AND COMMENTS

PROJECT DATA

202

TITLE Oil-bearing Microbes: Microbial Systems for Liquid Fuels

CONTRACT # Strategic Grant

ORGANIZATION Chemical Engineering
University of Toronto
Toronto, Ontario
M5S 1A4

PRINCIPAL INVESTIGATOR M. Wayman

DURATION November 1980 - November 1983

COST $108,990

SPONSOR Natural Sciences & Engineering Research Council

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$35,000			$35,000
1981-82	$38,990			$38,990
1982-83	$35,000			$35,000

REPORTS

Related publications as of 1980.

Lora J.H., and Wayman M., "Autohydrolysis of Aspen Milled Wood Lignin", Can. J. Chem., 58, (1980).

Wayman M., and Lora J.H., "Further Studies on Delignification of Wood by Autohydrolysis and Extraction", Tappi, 62(9), 113-114 (1979).

Lora J.H., and Wayman M., "Simulated Autohydrolysis of Aspen Milled Wood Lignin in the Presence of Aromatic Additives: Changes in Molecular Weight Distribution", J. Appl. Polym. Sci. 23, 1973 (1979).

Wayman M., and Lora J.H., "Simulated Autohydrolysis of Aspen Milled Wood Lignin in the Presence of Aromatic Additives: Structural Modifications", J. Appl. Polym. Sci. 24, 0000 (1980).

OBJECTIVE

This research has as its major objective identifying conditions under which suitable microbes generate high concentrations of liquid hydrocarbons or other high energy organic compounds with fuel potential. The ultimate objective is to formulate a microbial system for the reduction of carbonate to liquid fuels to contribute to energy supply.

DESCRIPTION

We have identified two different sets of conditions leading to high lipid formation: glut, and starvation. In the presence of high sugar concentrations, some microorganisms develop very high concentrations of lipid clearly visible in the electron microscope. These occupy nearly all of the volume of the organism. The other conditions for high lipid formation include P and/or N deprivation. Under these conditions growth is slow, and a useful process would have to be 2-stage: biomass production, and then oil generation.

The detailed research plan:

1. Arthrobacter Ak 19: complete studies of lipid generation and lipid composition through the life cycle; as a function of substrate concentration, pH, P deprivation, N deprivation; alternative C sources and a few other media variables.
2. Candida 107: to follow the patterns established with Arthrobacter Ak 19 (as in 1 above) to yield corresponding data.
3. Chlorella sp.: to obtain a fresh isolate of the Durum Lake Chlorella and review its growth requirements, energetics and metabolic products.
4. To establish, in the photomicrobiology laboratory, various configurations of interactive cultures of Chlorella (photosynthetics) and Arthrobacter Ak 19 or Candida 107.
5. To attempt to establish CO_2 fixation by immobilized Chlorella cells.
6. To re-establish the Chromatium-Desulforistella S-based anaerobic system, and introduce immobilized Chromatium (photosynthetic) cells into the system, as granules, a column or some other physical configuration.
7. Based on the above, to design and build a larger scale installation to make oil-bearing microbes, and to study the mass and energy blances involved.
8. Based on 7, to design a full-scale plant.

STATUS AND COMMENTS

4.3.7.10 Bioenergy Fundamental Studies/Oil Bearing Microbes. 23/3/82

PROJECT DATA

200

TITLE Continuous Ethanol Production using Immobilized Cells of Zymomonas Mobilis

CONTRACT # Strategic Grant

ORGANIZATION Faculty of Biochemical Engineering
University of Western Ontario
London, Ontario
N6A 5B9

PRINCIPAL INVESTIGATOR A. Margaritis

DURATION 3 years

COST $85,635

SPONSOR Natural Sciences & Engineering Research Council

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$27,500			$27,500
1981-82	$30,635			$30,635
1982-83	$27,500			$27,500

OBJECTIVE

A novel approach is proposed where immobilized cells of Zymomonas mobilis are to be used as catalysts for the continuous production of ethanol from carbohydrates. The proposed immobilized cell bioreactor systems have many potential advantages when compared to conventional batch fermentor systems used today for alcohol production.

DESCRIPTION

1) Optimization of Immobilization Mehtods. Three different methods of immobilization will be investigated.
   a) adsorption or covalent bonding of cells to small particles
   b) entrapment of cells in polyacrylamide gel and carrageen polymers
   c) microencapsulation of cells using different polymeric materials.
2) Bioreactor Development and Optimization. The immobilized cell system developed in Part 1 will be employed to develop bioreactor systems suitable for converting glucose to ethanol. The following bioreactor systems will be investigated:
   a) continuous packed bed column bioreactor
   b) continuous stirred tank bioreactor with micro screens to prevent passage of immobilized cells
   c) fluidized bed bioreactor using cells immobilized on solids with specific gravity between 2 and 3
   d) ordinary batch and continuous stirred tank bioreactor using freely suspended cells. This bioreactor system is used in today's fermentation industry. Data from this system will be compared with those obtained from the immobilized cell bioreactor systems.
3) Experimental Parameters. Experimental parameters to be studied for each bioreactor system include the following:
   a) flow rate and glucose concentration of feed
   b) ethanol concentration
   c) ethanol yields
   d) effects of temperature and pH
   e) half-life of the immobilized cells under different operating conditions
   f) ethanol productivity per unit bioreactor volume
   g) maximum glucose and maximum ethanol concentration levels at which yeast cells are inhibited and no ethanol production is possible.

REPORTS

Related publications as of 1980.

Margaritis A., Rowe G., and Baltus T., "Enzymatic Hydrolysis of Rice Hulls", Develop. Ind. Microbiol., Vol. 21, 1980 (in press).

Margaritis A., and Kennedy K, "The Application of an Air-Lift Fermentor in the Production of Biosurfactants", Develop. Ind. Microbiol., Vol. 21, 1980 (in press).

Margaritis A., and Creese E., "Toxicity of Surfactants in the Aquatic Environment: A Review", in "Waste Treatment and Utilization", editors Moo-Young M., and Farguhar G.J., pp. 445-462, Pergamon Press, Oxford, England, 1980.

Margaritis A., Zajic J.E., and Gerson D.F., "The Production and Surface Active Properties of Microbial Surfactants". Biotech. Bioeng. Vol. 21, No. 7, 1151-1162, 1979.

STATUS AND COMMENTS

4.3.7.11 Bioenergy Fundamental Studies/Immobilized Cell Techniques for Fuel Production. 23/3/82

SOCIO-ECONOMIC-TECHNICAL STUDIES

PROJECT DATA

174

TITLE Feasibility of Adapting Current Technology to Generate Electricity for Remote Areas

CONTRACT # KL229-1-4108 OSS80-00235 C-178

ORGANIZATION S.N.C. Inc.
1 Complexe Desjardins
C.P. 10, Succursale Desjardins
Montreal, Quebec. H5B 1C8

PRINCIPAL INVESTIGATOR F.W. Eyre

DURATION April 1981 - July 1981

COST $27,791

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Place Vincent Massey
Hull, Québec

TECHNICAL LIAISON OFFICER: Dr. D.R. Huffman
Forintek Canada Corporation
Eastern Laboratory
800 Montreal Road
Ottawa, Ontario
K1G 3Z5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$27,791			$27,791

OBJECTIVE

Primary - To determine the feasibility of developing a reliable electricity generating packaged system for remote communities based on locally available wood and wood waste supplies as an energy source, by adapting currently available steam engine technology.

Secondary - To evaluate whether the wood burning system technology applicable to steam generation would also be applicable for space heating.

DESCRIPTION

The feasibility study will comprise:

a) Definition of a preliminary range of system sizes.
b) A review of applicability of reciprocating steam engines vs steam turbines as primary power units.
c) A review of the requirements for stationary enginemen.
d) Preparation of preliminary design layout(s).
e) Resumé of preliminary system costs.
f) An assessment of numbers of potential applications:
   - Number of remote communities with access to adequate wood (or peat) supplies.
   - Number of communities with requirements of less than 250 HP.
g) An assessment of adaptations or modifications of existing equipment, necessary or desirable.
h) An assessment of methods of wood gathering and supply.
i) A comparison of installation and operating costs relative to diesel installations.
j) A comparative assessment of competing systems e.g. Micro-hydro.
k) A draft plan for system development, demonstration, installation and commercialization.
l) Consideration of user "response".

REPORTS

Production of Electricity Generation by Wood-Fired Steam Engines for Remote Communities by S.N.C. Inc., December 1981. ENFOR Project C-178.

STATUS AND COMMENTS

Project complete.

4.3.8.2 Socio-Economic-Technical Studies/Technology Assessment.

15/3/82

PROJECT DATA

177

TITLE Forest Product Based Sacrificial Agents for Enhanced Oil Recovery

CONTRACT # KL229-1-4117 OSS81-0047 C-191

ORGANIZATION B.C. Research
3650 Wesbrook Mall
Vancouver, B.C. V6S 2L2

PRINCIPAL INVESTIGATOR Dr. John Howard (604)224-4331

DURATION April 1981 - March 1983

COST $152,750

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Place Vincent Massey
Hull, Québec

TECHNICAL LIAISON OFFICER: J.F.G. Mackay
Forintek Canada Corporation
Western Laboratory
6620 NW Marine Drive
Vancouver, B.C.
V6T 1X2

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$87,450			$87,450
1982-83	$65,300			$65,300

REPORTS

OBJECTIVE

To evaluate suitable silvichemicals and their appropriate derivatives as sacrificial agents for use in tertiary oil recovery systems.

To approach oil companies actively developing surfactant dependent enhanced oil recovery processes for further evaluation of these sacrificial agents (especially in the field).

To approach chemical marketing companies with a vested interest in marketing effective sacrificial agents to promote further sale of their surfactants.

DESCRIPTION

Isolation of Sacrificial Agents

The following byproducts of the forest products industry are thought to have potential as starting materials for sacrificial agent manufacture:

- Kraft black liquor lignin and carbohydrate components.
- Spent sulphite liquor (red liquor) lignin and carbohydrate components.
- "E"-stage liquor from both kraft and sulphite pulp bleaching stages.
- Prehydrolysis liquor from pretreatment of both chips for pulping and sawdust for conversion into hardboard (Masonite).

The evaluation procedure will take the following form. Well defined mont-morillonites will be exposed to solutions of the potential silvichemical sacrificial agents. The adsorption of these agents on the clays can be followed by ultra-violet adsorption spectroscopy where suitable chromophores are present or chemically by total organic carbon analysis. The treated clay will then be exposed to solutions of de-oiled petroleum sulfonates of differing equivalent weights covering the range normally used in oil recovery.

Adsorption of surfactant will be monitored by sulfonate analysis. Comparison of surfactant adsorption with and without pretreatment with silvichemical derivatives will be carried out to identify particular derivatives having potential as sacrificial agent and to ascertain general correlations between the ability of a derivative to function as a sacrificial agent and its physical charcteristics (charge, hydrophilic/lipophilic balance, etc.).

Initially experiments will be carried out in sodium chloride solution using sodium montmorillonite. Later the performance of selected sacrificial agents will be evaluated on calcium montmorillonite which has the potential to act as a source of Ca^{2+} ions capable of precipitating the petroleum sulfonates. A sacrificial agent should have the ability to not only coat the clay surfaces to prevent sulfonate adsorption but to contain the Ca^{2+} ions within the clay structure.

STATUS AND COMMENTS

The results look promising and a patent application is being filed. Bioenergy Program - 11/3/82

PROJECT DATA

178

TITLE Technical Assessment of Downdraft Gasifiers

CONTRACT # KL229-1-4118 OSS81-00022 C-197

ORGANIZATION Department of Chemical Engineering
Queen's University
Kingston, Ontario. K7L 3N6

PRINCIPAL INVESTIGATOR Dr. D.W. Bacon (613) 547-3202

DURATION April 1981 - May 1983

COST $185,550

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.P. Overend
National Research Council
Montreal Road
Room 206
Buiding M-50
Ottawa, Ontario
K1A OR6

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$86,380			$86,380
1982-83	$91,738			$91,738
1983-84	$ 7,542			$ 7,542

OBJECTIVE

To develop and test quantitative methods to assess the operation and design of down-draft gasifiers.

DESCRIPTION

1. Mechanistic and empirical models of down-draft wood gasifiers;
2. Computer simulation programs incorporating these models;
3. Experimental design and data analysis procedures to obtain data and extract information efficiently for assessing and improving the operation of down-draft wood gasifiers;
4. Procedures for establishing limits on the reliability and acceptability of data from gasifier operation.

REPORTS

STATUS AND COMMENTS

Working in collaboration with J. Downie and C.C. Hsu.

PROJECT DATA

190

TITLE A review of the options available to the forest industry for producing electricity from wood residues

CONTRACT # KL229-1-4107 OSS81-00007 C-185

ORGANIZATION B.H. Levelton & Assoc. Ltd.
8805 Osler Street
Vancouver, B.C.
V6P 4G1

PRINCIPAL INVESTIGATOR

DURATION April 1981 - March 1982

COST $48,917

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Place Vincent Massey
Hull, Québec

TECHNICAL LIAISON OFFICER: Dr. D.R. Huffman
Forintek Canada Corporation
Eastern Laboratory
800 Montreal Road
Ottawa, Ontario
K1G 3Z5
(613) 744-0963

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$48,917			$48,917

REPORTS

OBJECTIVE

1. To review and evaluate the systems available for developing electrical energy from wood residues, generally in sizes less than 5 MW.
2. To study existing installations and to develop performance data which can be applied to other situations.
3. To evaluate operating systems (proven) and to assess the potential of those systems which are in a development or prototype stage.
4. To develop a format for presenting information which the forest industry can use for selecting systems to develop electric power from wood waste.

DESCRIPTION

The proposed study will consist of a state-of-the-art review of existing technology with critical assessment of systems and development of economics for each system. The method for developing the required data will involve completion of the following tasks:

1. Define those systems which are applicable to wood residues and which are effective in the range up to 5 MW, typically as shown below:

   a) Packaged hog fuel boilers.
   b) Steam generated indirectly via hot oil with turbines and engines (generally low pressure steam but avoid conventional steam plant).
   c) Hot combustion gases used with turbines.
   d) Wood gasification with use of cleaned gas.
   e) Hot combustion gases exchanged with another power fluid, as in the Stirling engine.
   f) Waste heat boilers added to existing wood residue combustors with turbines and steam engines.

2. Prepare an assessment of the available systems which will permit the potential user to select that system which best suits his particular condition.

   a) Combination with existing facilities.
   b) Fuel type, quality and amount available.
   c) Reliability required of electric generation.
   d) Price of purchased electric power (if available) with which self-generated power must compete.

3. Present data in a format which can be used readily by all users and which can be amended and added to as further information becomes available.

STATUS AND COMMENTS

4.3.8.2 Socio-Economic-Technical Studies/Technology Assessment. 15/3/82

PROJECT DATA

232

TITLE State-of-the-art Document on the Enzymatic Hydrolysis of Cellulose (Lignocelluloses)

CONTRACT # 04SX.31155-1-2693

ORGANIZATION Devinder Chahal Enterprises Inc.
312-1800 Baseline Road
Ottawa, Ontario
K2C 3N1

PRINCIPAL INVESTIGATOR Dr. Devinder Singh Chahal

DURATION January 1982 - March 1982

COST $17,600

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Lyse Morisset
Bioenergy Program
National Research Council
Division of Energy, Research & Development
Room 381, Building M-55
Ottawa, Ontario
K1A 0R6
(613) 993-3142

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$17,600			$17,600

OBJECTIVE

To develop a State-of-the-art document on the enzymatic hydrolysis of cellulose.

DESCRIPTION

This document on the enzymatic hydrolysis of cellulose will be a summary of the significant findings as recorded in the literature, commercial experiences, and the opinions of the recognized experts in the field. The summary is not expected to deal with or include specific results of individual studies; however, it is expected to answer the following questions:

Which commercially feasible processes are available to produce cellulose suitable for enzymatic hydrolysis from various biomass sources?

What types, activities and quantities of cellulolytic enzymes are required per unit of cellulose for a given substrate, rate of hydrolysis (kg cellulose/m³ reactor/hour) and end product (sugar) concentration?

Which commercially feasible processes are available for the production of cellulolytic enzymes in the quantities required for commercial hydrolysis processes?

Which commercially feasible processes are available for the hydrolysis step itself?

How critical are the aseptic requirements for proceses mentioned under the above 2 sections?

What are the short and medium term technical limitations of the processes mentioned above in order of urgency for a solution? (in this connection it would be valuable to discuss the pros and cons of continuous vs. batch operations, anaerobic vs. aerobic systems, reuse of enzymes and thermophilic operations.)

What restraints, if any, are put on the enzymatic hydrolysis process by the further use of the sugars produced (such as for food or conversion to alcohol or other chemical feedstocks)?

To the extent that the economics of cellulose hydrolysis is dependent on the recovery and utilization of lignin and hemicelluloses, what technical problems with the recovery of these products constitute restraints in the commercialization of cellulose hydrolysis?

REPORTS

STATUS AND COMMENTS

Final report will be ready by March 31, 1982.

4.3.8.2 Socio-Economic-Technical Studies/Technology Assessment.

23/3/82

PROJECT DATA

239

TITLE Operating and Developing a Computer Model Wood to Ethanol

CONTRACT # 31155-1-2650 (OSX81-00107)

ORGANIZATION Ontario Research Foundation
Sheridan Park Research Community
Mississauga, Ontario
L5K 1B3

PRINCIPAL INVESTIGATOR R.J. Laughlin

DURATION December 1981 - March 1983

COST $41,780

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Ralph Overend
National Research Council
Room 206, Building M-55
Ottawa, Ontario K1A 0R6
(613) 993-3405

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1982-83	$41,780			$41,780

OBJECTIVE

In order to assist the NRC in the development of research strategies in biotechnological routes to alcohol, the NRC has obtained an agreement to use for its own purpose a model computer program for use in wood to ethanol technology studies (developed by Imperial Oil Ltd., of Toronto, Ontario; licensed to the National Research Council solely for its own use). The model will be extensively modified to incorporate additional and substitute unit processes and to investigate the effects of various feedstocks and process plant scale.

DESCRIPTION

Task A: Perform the following alterations to the model:
1) Change the costing procedure from that now in place to a supply price estimation method.
2) Modify the feedstock composition so that it can allow for both softwood and hardwood inputs.
3) Replace the existing Imperial with metric input and output units.
4) Modify the existing unit module to incorporate appropriate heat recovery technologies (e.g. heat exchanger).

Task B: Prepare an operator's manual for the Process model.

Task C: Using available data on the so-called "Madison" Process with and without pentose recovery such as that contained in the work of E.E. Harris and J.F. Saeman, operate the model as a base case 200 ODt/day of feedstock. Prepare sensitivity analysis for variation in:
1) Scale (50, 100, 500 and 1000 tpd).
2) Idenfify the most significant variables (e.g. feedstock cost and by-product credits - carbon dioxide, fodder yeast, calcium sulphate, methanol, furfural) and evaluate the sensitivity of these.

Task D: Prepare a new model utilizing both the hemicellulose residue as well as stillage as a feedstock to an advanced NRC type anaerobic fixed film digestor. Sludge from this module to be treated as either a land amendment or as a protein re feed. Methane to be utilized as an inplant fuel. Test this unit process in the previously described Madison base case described in Task C.

REPORTS

STATUS AND COMMENTS

4.3.8.3 Socio-Economic - Technical Studies/Economic & Technology Assessment. 28/3/82

MATERIALS HANDLING, TRANSPORTATION AND PRE-TREATMENT

PROJECT DATA

182

TITLE RF Transmission for Feedstock Moisture Content Determination

CONTRACT # KL229-1-4105 (OSS81-00001) C-221

ORGANIZATION Avtech Electro-Systems
P.O. Box 5611 Stn. F.
Ottawa, Ontario

PRINCIPAL INVESTIGATOR Dr. W.J. Chudobiak

DURATION April 1981 - August 1981

COST $31,500

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Place Vincent Massey
Hull, Québec

TECHNICAL LIAISON OFFICER: Dr. D.R. Huffman
Forintek Canada Corporation
Eastern Laboratory
800 Montreal Road
Ottawa, Ontario
K1G 3Z5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$31,500			$31,500

OBJECTIVE

Experimentally confirm that the RF transmission line phase methods successfully developed in Phase I (Carleton University contract) for static measurements on waste material will accurately determine moisture content of bulk feedstock material placed on a moving conveyor system (with varying volume) and to conduct preliminary circuit design of RF source and phase measuring electronics. The prototype sensor and electronics to be developed in the proposed program will be suitable for field trials in a subsequent phase during which the sensor design would be finalyzed and signal analysis methods studied and perfected.

DESCRIPTION

It is proposed to construct in the laboratory a portion of a moving conveyor system and to experimentally confirm that the parallel bar methods developed for static moisture measurements in Phase I will accurately determine moisture content under moving sample conditions and fluctuating volume conditions. The relative merits of locating the sensor on the surface of the waste material (i.e. directly in contact with the material) and placing it on the bottom side of a rubber conveyor belt will be studied. In addition the merits of large parallel bar sensor straddling both the waste material and the conveyor belt will be studied. Initially all sensor development and measurements will be conducted using laboratory instruments, principally RF signal generators and the vector voltmeters (in order to significantly reduce costs, a network analyzer system will not be used). However, as the final form of the sensor is defined, an effort will be made to design prototype signal source circuits and phase measurement circuits which will yield an analog output voltage proportional to the moisture content. The frequency range of 200 to 300 MHz will be employed as this will yield a reasonable compromise between sensor size and sensitivity and project cost. The overall project will attempt to demonstrate that the final source and phase electronics will yield moisture content information without undue and frequent recalibration to account for drift, aging, interference, motion, and volume variations.

REPORTS

Avtech Electrosystems Ltd., RF Transmission Line Methods for Feedstock Moisture Content Determination (Phase II). Ottawa, Ontario, October 1981. ENFOR project C-221.

STATUS AND COMMENTS

Complete. See data sheet #158 for Phase I.

PROJECT DATA

154

TITLE Bin and Silo Design for Biomass Materials

CONTRACT # KL229-0-4120 (OSS80-43) C130

ORGANIZATION B.C. Research
3650 Wesbrook Mall
Vancouver, B.C. V6S 2L2

PRINCIPAL INVESTIGATOR N. Bundalli

DURATION 2 years

COST $233,300

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Vincent Massey Building
Hull, Québec K1A 0E7
(613) 997-1682

TECHNICAL LIAISON OFFICER: Dr. J.F.G. Mackay
Forintek Canada Corporation
Western Laboratory
6620 NW Marine Drive
Vancouver, B.C. V6T 1X2
(604) 224-3221

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$115,100			$115,100
1981-82	$118,200			$118,200

REPORTS

OBJECTIVE

1. To design and construct a shear testing apparatus suitable for biomass materials in order to obtain data necessary for better design of bins and silos used for storing such materials.
2. To test different types fo biomass materials under varying conditions so as to make suitable recommendations on bin and silo design as well as material conditioning (where appropriate) to achieve uninterrupted and uniform discharge.
3. To identify factors which contribute to poor flow properties.

DESCRIPTION

A shear testing apparatus with a large enough cell to hold sufficient quantity of a woodwaste material will be designed in detail.

The apparatus will have some of the features of the Jenike Tester but with a cell diameter of 76.2 cm. Shearing will be carried out by pulling the top half of the cell by means of a steel cable attached to the cell, preferably at a constant rate to achieve a steady strain rate. The stress required to shear the material will be measured by a suitable tensile transducer connected to the steel cable.

For wall friction tests, the bottom cell ring will be replaced by a plate of the bin wall material to be tested. Several plates will be made up of different construction materials, some with special linings used to reduce wall friction.

Several extra cells will be made up to carry out time consolidation tests to determine the effect on the flow properties of storing woodwaste materials in bins over periods of time without discharging. Since individual components of the apparatus are likely to be of considerable weight and size, adequate provision will be made for lifting and manoeuvering the items with ease.

Following construction of the shear testing apparatus, some trial tests will be carried out to check the equipment for proper functioning. Any necessary modifications will be done.

STATUS AND COMMENTS

The contract is to include an examination of the effects of cold weather conditions and also study the storage of peat.

PROJECT DATA

157

TITLE Advanced Feedstock Preparation System for Large-Scale Hog Fuel Boilers

CONTRACT # KL229-0-4170 (OSS80-36) C149

ORGANIZATION Inproheat
680 Raymur Avenue
Vancouver, B.C.
V6A 2R1

PRINCIPAL INVESTIGATOR Greg Hall

DURATION April 1980 - March 1982

COST $125,630

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Place Vincent Massey
Hull, Québec
K1A 0E7
(613) 997-1682

TECHNICAL LIAISON OFFICER: Dr. T.F.G. MacKay
Forintek Canada Corporation
Western Laboratory
6620 NW Marine Drive
Vancouver, B.C.
V6T 1X2

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$32,648.04			$32,648.04
1981-82	$92,981.96			$92,981.96

OBJECTIVE

1. To measure combustion parameters (temperature, gas composition and particulate loading) for a range of operating conditions at the interface between solid fuel combustion and gas phase combustion above the grate of a relatively large scale hog fuel boiler.
2. To quantitatively relate fuel characteristics (moisture content and size distribution) to boiler performance (unit steaming capacity, control response, efficiency and stack emissions).
3. To evaluate feasibility of a secondary flash dryer for reducing moisture content of the fines fraction of the product from a rotary dryer and to optimize design parameters, including inlet and outlet temperatures, velocity, length and configuration.
4. To specify criteria for improved hog fuel boiler performance.

DESCRIPTION

1. Design and fabricate a special probe and modify existing sampling train equipment, as required, to collect and analyze high temperature samples from the solid phase/gas phase interface zone.
2. Measure interface parameters - temperature, gas composition (O_2, CO_2, H_2O, CO, C_xH_y), and particulate loading at selected boiler operating conditions for a range of fuel characteristics.
3. Design, fabricate and construct a pilot scale secondary flash dryer.
4. Start-up and optimize operation of the pilot scale flash drying system.
5. Obtain representative samples of fuel fractions from the rotary dryer and from the suspension dryer and evaluate the feasibility of using proven process equipment for operations which could form elements of advanced fuel preparation systems.
6. Conduct controlled tests relating boiler operating parameters (unit steaming capacity, control response, efficiency, and stack emissions) to fuel characteristics (moisture content and size classification) for grate firing.

REPORTS

STATUS AND COMMENTS

PROJECT DATA 181

TITLE Fuel value of stored forest/mill residues

CONTRACT # KL229-1-4106(OSS81-00035)

ORGANIZATION Forintek Canada Corp.
Eastern Laboratory
800 Montreal Road
Ottawa, Ontario
K1G 3Z5

PRINCIPAL INVESTIGATOR H. Unligil

DURATION May 1981 - March 1982

COST $31,135

SPONSOR Environment (C-220)

SCIENTIFIC AUTHORITY Dr. R.P. Overend
National Research Council
Room 206, Building M-50
Ottawa, Ontario K1A 0R6
(613) 993-3405

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$31,135			$31,135

OBJECTIVE

1. To conduct a survey of the literature on: conditions existing in outside piles of woody particles (wood chips, forest and mill residues); factors involved in the decrease of calorific value of wood; and, measures to prevent storage losses.
2. To discuss recent developments in the use of forest biomass as an energy source, and their possible impact on storage practices.
3. Indicate areas to which research should be directed.

DESCRIPTION

Literature survey.

A. An introduction to provide information on the fuel value of wood and methods of measurement of the fuel value; the deterioration of wood generally; the current handling and storage practices, volume, and economic significance of the forest biomass.
B. Moisture content of stored piles of woody particles: the sources of moisture, its significance in deterioration and loss of fuel value of wood.
C. Heat generation phenomenon: its causes; the factors influencing its development; and its consequences.
D. Deterioration of wood resulting in a loss in calorific value: the rate of deterioration. Microbial deterioration will receive special attention. Weight loss changes in chemical composition and their effect on fuel value.
E. Methods of reducing storage losses; physical methods; chemicals; biological protection.
F. Environmental consequences of fuelwood storage and chemical and biological treatments.
G. Propects and recent developments in use of biomass materials as energy source and their implications to the storage practice of woody particles.

REPORTS

STATUS AND COMMENTS

4.3.9.2 Biomass Materials Handling, Transportation and Pretreatment/Materials Handling. 28/3/82

PROJECT DATA

189

TITLE The development of machinery for the recovery and preparation of biomass feedstocks for conversion systems at a central full tree processing complex

CONTRACT # KL229-1-4123(08881-00008) C-253

ORGANIZATION Logging Development Corporation
5858 Côte des Neiges
Suite 215
Montreal, Québec
H3S 1Z1

PRINCIPAL INVESTIGATOR D.D. Hamilton

DURATION April 1981 - March 1982

COST $69,015

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Place Vincent Massey
Hull, Québec
(613) 997-1682 K1A 0E7

TECHNICAL LIAISON OFFICER: J. Kryla
Eastern Laboratory
Forintek Canada Corporation
800 Montreal Road
Ottawa, Ontario K1G 3Z5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$69,015			$69,015

OBJECTIVE

The development of machinery for the recovery and preparation of biomass feedstocks to fuel conversion systems at a central full-tree processing complex.

DESCRIPTION

1. To execute technical and economic studies related to machinery for the recovery and preparation of biomass feedstocks for conversion systems at a central full-tree processing complex.

2. To select known components, to conceive new components, and to combine the two in an integrated design for a full scale test section as shown on Logging Development Corp. drawing E-15954.

3. To complete the designs for the test section to a state where they can be detailed. The designs will consist of an infeed table, a residue conveyor, a two-stage residue reducer, a feeding/limbing device and supporting structure, and an outfeed receiving table.

4. To construct a model of the test section to a scale of thirty to one in sufficient detail that all of the technical principles involved are clear to a non-technical observer.

REPORTS

STATUS AND COMMENTS

PROJECT DATA 193

TITLE A Study of the Forces Exerted by Hog Fuel Piles on Restraining Structures

CONTRACT # KL229-1-4217(0SS81-00096) C-254

ORGANIZATION B.H. Levelton and Associates Ltd.
8805 Osler Street
Vancouver, B.C.
V6P 4G1

PRINCIPAL INVESTIGATOR

DURATION September 1981 - July 1982

COST $88,000

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Place Vincent Massey
Hull, Québec K1A 0E7
(613) 997-1682

TECHNICAL LIAISON OFFICER: Dr. J.F.G. Mackay
Forintek Canada Corporation
Western Laboratory
6620 NW Marine Drive
Vancouver, B.C. V6T 1X2
(604) 224-3227

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$60,000			$60,000
1982-83	$28,000			$28,000

OBJECTIVE

To undertake field measurements to develop basic data on the lateral forces exerted by hog fuel piles (work will be done at real scale under plant conditions so that realistic information will be obtained).

1. as a function of pile depth
2. as affected by vehicular traffic on the pile
3. as a function of moisture
4. variations with time
5. as affected by loading or unloading of the pile
6. to produce data for engineers to provide a basis for designing fuel storage areas.

DESCRIPTION

1. To conduct a survey of the potential mill sites for the project in the Vancouver area by H.A. Simons Int. Ltd.

2. To conduct a survey of instrumentation to identify what types are best suited to the requirements.

3. Pressure sensors and transducers will be selected for point force measurements and gross force.

4. Height of fuel pile immediately above the sensor and at a distance of 10 ft. from the wall will be recorded by mechanical sounder.

5. Force on the wall will be measured away from the corners of the bin on a vertical wall approximately 2 ft. above the floor. A gross force measurement and a point force measurement will be taken at the same level. One point force measurement will be taken at some level higher above the floor.

REPORTS

STATUS AND COMMENTS

On the basis of work completed by August 1981 two sites were selected for data collection.

Phase one of the study will be at Crown Zellerbach, Coast Wood Products Division of Coquitlam, B.C.

Phase two will be at Canadian Forest Products of New Westminster, B.C.

PROJECT DATA

223

TITLE Feasibility study and design concepts for hybrid poplar biomass transportation system

CONTRACT # 31155-1-2674-P (OSX81-00124)

ORGANIZATION Lloyd Walker Consulting Ltd.
308 - 370 Dominion Avenue
Ottawa, Ontrio
K2A 3X4

PRINCIPAL INVESTIGATOR Lloyd B. Walker

DURATION January 1982 - March 31, 1982

COST $15,978

SPONSOR National Research Council

SCIENTIFIC AUTHORITY Theodore B. Golob
Bioenergy Program
Division of Energy Research and Development
National Research Council
Room 382, Building M-55
Ottawa, Ontario K1A 0R6
(613) 993-1342

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$15,978			$15,978

OBJECTIVE

To conduct feasibility study and provide design concepts for a hybrid poplar biomass transportation system designed within the given operational and economic constraints.

DESCRIPTION

1. Review the available information on similar transportation systems for field and highway operations; provide preliminary calculations on the principal parameters of equipment sizing, optimum unit dimensions, wheel and tire types and sizes, tractive effort and power requirements.

2. Establish guidelines for transportation system designs and their interaction with the harvesting operation; prepare plans and mathematical models of different systems; review and select a final concept and/or alternatives.

3. Prepare a report on selected concepts to include the following information:

- cost estimates for manufacture of units
- cost of operation
- maintainability
- economic justification and feasibility

REPORTS

STATUS AND COMMENTS

4.3.9.3 Biomass Materials Handling, Transportation & Pretreatment/Transportation. 23/3/82

PROJECT DATA

146

TITLE Development of a moisture resistant densified solid fuel from forest biomass

CONTRACT # KL229-0-4084 (OSS80-97) C97

ORGANIZATION B.H. Levelton & Associates
1755 West Fourth Avenue
Vancouver, B.C. V6J 1M2

PRINCIPAL INVESTIGATOR

DURATION July 1980 - July 1981

COST $75,739.61

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY Mr. R.J. Neale
Canadian Forestry Service
Environment Canada
Hull, Québec K1A 1G5

TECHNICAL LIAISON OFFICER: Dr. D.R. Huffman
Forintek Canada Corporation
Eastern Laboratory
800 Montreal Road
Ottawa, Ontario
K1G 3Z5

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1980-81	$47,000			$47,000
1981-82	$28,739.61			$28,739.61

OBJECTIVE

There exist a number of commercial processes and systems for the production of densified biomass fuel (DBF). All of these systems produce a fuel with excellent combustion characteristics and good handling properties that can be economically competitive with other fuels. There is one major disadvantage to all of these systems - the product is not water stable and must be stored in dry places to prevent disintegration when wetted with water.

In order to expand the commercial market for DBF it is necessary to develop a product that has sufficient moisture resistance to allow it to be stored, exposed to weather, for 60 - 90 days without losing its attractive handling properties and density.

DESCRIPTION

The scope of this work encompasses the following aspects:

1) Testing of current commercial DBF in order to establish base performance in terms of moisture resistance and physical characteristics.

2) Exploration of the basic parameters of pressure, temperature, moisture content, fibre characteristics, time, etc., which could lead to a moisture-resistant self-bonded DBF.

3) Evaluation of the use of binders for DBF production.

4) Consideration of thermochemical processing for DBF production.

5) Production and testing of the developed moisture resistant DBF on a laboratory scale.

REPORTS

Development of a Moisture Resistant Densified Solid Fuel From Forest Biomass, by B.H. Levelton & Associates Ltd., Vancouver, B.C., December 1981.
(Available from ENFOR Secretariat and Energy Library, CISTI)

STATUS AND COMMENTS

4.3.9.4 Biomass Materials Handling, Transportation & Pretreatment/Pretreatment. 31/3/82

PROJECT DATA 180

TITLE To Perform a Study of Hog Fuel Drying Using Vapour Recompression C-214

CONTRACT # KL229-1-4120

ORGANIZATION Pulp and Paper Research Institute
570 St. John's Blvd.
Pointe Claire, Québec
H9R 3J9

PRINCIPAL INVESTIGATOR W.R. Aird

DURATION May 1981 - March 1982

COST $134,806

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY R.J. Neale
Place Vincent Massey
Hull, Québec K1A 0E7
(613) 997-1682

TECHNICAL LIAISON OFFICER: D.R. Huffman
Forintek Canada Corporation
Eastern Laboratory
800 Montreal Road
Ottawa, Ontario K1G 3Z5
(613) 744-0963

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$134,806			$134,806

OBJECTIVE

To evaluate experimentally the pertinent parameters of two conceptual processes fo drying hog fuel, and to assess the feasibility of applying vapour recompression to these processes.

DESCRIPTION

A. The design and construction of a laboratory-scale dryer consisting of an internally heated vessel, steam generator, vapour condenser and appropriate controls and instrumentation. The vessel will be operated batchwise, and drying rates determined from the flow rates of condensed vapours.

B. Testing of the dryer, with hog fuel from different sources, to determine the drying of hog fuel as a function of:
1. steam condensing temperature
2. size of hog fuel particles (including bark produced in PAPRICAN's chip debarking process)
3. the moisutre content of hog fuel.

C. Experimental system will be tested with crude tall oil as heating medium followed by determination of the hog fuel drying rates as a function of the variables in B. The degree of oil entrainment with wood and losses due to evaporation will also be measured. The pollution characteristics of the condensates will be determined on some selected samples.

D. Tests will be done to determine feasibility and product characteristics of prepared densified fuel from the product derived in C.

E. A technical and economic assessment and comparison of the two vapour recompression drying systems based on the information gained in B, C, D. A preliminary design of a continuous pilot-scale dryer.

REPORTS

STATUS AND COMMENTS

4.3.9.4 Biomass Materials Handling, Transportation and Pretreatment/Pretreatment. 23/3/82

PROJECT DATA 183

TITLE A study of the pretreatment preparation of forest biomass as feedstock for bioconversion processes

CONTRACT # KL229-1-4121(OSS81-00026) C-222

ORGANIZATION University of Waterloo
Waterloo, Ontario
N2L 3G1

PRINCIPAL INVESTIGATOR D. Murray Moo-Young

DURATION May 1981 - April 1983

COST $129,221

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY Dr. S.M. Martin
Division of Biological Sciences
National Research Council
Room 3024, Sussex Drive
Ottawa, Ontario
K1A OR6

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$58,000			$58,000
1982-83	$65,931			$65,931
1983-84	$ 5,290			$ 5,290

OBJECTIVE

To develop and test a novel process whereby forest biomass (as wood, pulpmill sludge) is converted by chemical hydrolysis, enhanced by gamma irradiation or microwaves, into a liquid product which is suitable as feedstock for known conversion technologies in the production of industrial chemical and fuels. The aim is enconomic production of feedstocks.

DESCRIPTION

The project will cover two main areas of study.

1. Experimental development of the pretreatment method for optimal depolymerization, sugar yields and conversion rates. The effects of irradiation dosage, particle size and chemical strength will be examined. The prepared feedstocks will be tested in actual bioconversion processes to gain insight in its suitability.

2. Economic evaluation of the method as it compares to existing feedstock availability and other pretreatment methods for a range of conversion technologies. Computer programs will be developed for various sensitivity analyses.

REPORTS

STATUS AND COMMENTS

4.3.9.4 Biomass Materials Handling, Transportation and Pretreatment/Pretreatment. 23/3/82

PROJECT DATA

192

TITLE Design, fabrication and testing of a prototype log splitter

CONTRACT # KL229-1-4162 (OSS81-00085) P-216

ORGANIZATION Forest Engineering Research Inst. of Canada
143 Place Frontenac
Pointe Claire, Québec
H9R 4Z7

PRINCIPAL INVESTIGATOR Denis Brière

DURATION July 1981 - March 1982

COST $119,500

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY C.R. Silversides
Bioenergy Program
Energy Division
National Research Council
Room 381, Building M-55
Ottawa, Ontario
K1A 0R6

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$119,500			$119,500

REPORTS

OBJECTIVE

To design, build and test a roll splitter capable of continuously splitting woody biomass up to 30 cm in diameter and simultaneously reducing its moisture content.

DESCRIPTION

1. To develop a design for a portable roll splitter capable of continuously splitting wood parallel to the grain, crushing its structural integrity and reducing its moisture content.

2. To prepare all necessary shop drawings and specifications for all components.

3. To fabricate one (1) experimental prototype of the log splitter from the design, drawings and components from (2) above.

4. To field test the experimental prototype and measure its energy consumption, hydraulic forces, productivity, and general performance.

STATUS AND COMMENTS

Sub-contract to K.C. Jones and Associates Ltd.

4.3.9.4 Biomass Materials Handling, Transportation and Pretreatment/Pretreatment. 23/3/82

PROJECT DATA

215

TITLE Assessment of Wet Oxidation of Agricultural Residues to Form Fermentation Substrates

CONTRACT # 34SZ.01843-0-B103 (OSZ81-43)

ORGANIZATION Ontario Research Foundation
Sheridan Park Research Community
Mississauga, Ontario

PRINCIPAL INVESTIGATOR Duncan Smith

DURATION August 1981 - September 1982

COST $120,000

SPONSOR Agriculture Canada

SCIENTIFIC AUTHORITY D. Hayes
Engineering & Statistical Research Institute
Building 94
Agriculture Canada
Ottawa, Ontario

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$70,000			$70,000
1982-83	$50,000			$50,000

OBJECTIVE

The overall objective of the project is to develop and test a system that converts corn stover to a fermentable substrate by using a combination of acid hydrolysis reactors and wet oxidation of residual lignin and swine manure or stover/manure mixtures. The system will produce pentose and hexose sugar streams of high theoretical yield (60% or more) that are sterile and can be fermented to fuel ethanol in particular or others such as acetone, and butanol. The system is intended to generate most of its own requirements for acid, energy (steam), and essential nutrients for fermentation.

DESCRIPTION

Phase 1: (The Hydrolysis System)
The contractor will perform preliminary investigations of a "hydrolysis system" using separate reactors for acetic acid and steam hydrolysis of corn stover which will yield pentose and hexose sugar streams. Lignin residue from the cellulose hydrolysis reactor will be wet oxidized using the WETOX^{R} reactor to optimize steam and acetic acid production, reaction kinetics and process conditions relative to the requirements of the hemicellulose and cellulose hydrolysis reactors. The experiments will be carried out in a batch/bench scale configuration where system integration is simulated only. For each promising sugar stream produced in the experiments, studies to ensure that the sugar streams are fermentable will be conducted at the flask scale (anaerobically, where practical). (Note: Fermentability studies refer primarily to hexose sugar streams). Preliminary investigations only of fermenting pentose sugar streams to fuel ethanol will be conducted.

Phase 2: (The Manure Treatment System)
Upon written approval of the scientific authority the contractor will perform basic research studies on: 1) wet oxidation of swine manure to supply nutrients (for fermentation) and/or steam and acid; 2) wet oxidation of manure/lignin mixtures to supply nutrients and/or steam and/or acid and; 3) oxidative hydrolysis of stover/manure mixtures to supply nutrients, steam, acid and/or fermentable carbohydrates. Products from these experiments (e.g. steam, acid, nutrients, fermentable carbohydrates) will be studied with respect to fermentability (as described in Phase 1) in experiments using sugar streams produced in Phase 1 experiments and on products derived solely from wet oxidation of manure or stover/manure mixtures.

REPORTS

STATUS AND COMMENTS

PROJECT DATA

234

TITLE Microbial Fractionation of Native Biomass to Lignin, Cellulose and Hemicellulose

CONTRACT # Strategic Grant

ORGANIZATION Queen's University
Department of Chemical Engineering
Kingston, Ontario
K7L 3N6

PRINCIPAL INVESTIGATOR D.H. Bone

DURATION 3 years

COST $87,000

SPONSOR Natural Sciences & Engineering Research Council

SCIENTIFIC AUTHORITY N/A

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$38,000			$38,000
1982-83	$24,000			$24,000
1983-84	$25,000			$25,000

REPORTS

OBJECTIVE

To develop a fermentation process which will convert wood, bark, straw and other native lignocellulosics (LC) into free lignin, cellulose and hemicellulose using lignolytic fungi. Lignin will be further processed into aromatics and phenols by microbes. Cellulose and hemicellulose will be available in an easily utilizable form for conversion to sugars, which can then be used as a substrate for the production of liquid fuels (e.g. ethanol). Two bioreactors will be used: a recirculating tower bioreactor and a fluidized bed reactor. The microbial conversion of LC to lignin and polysaccharides will be optimized for minimum energy use and economics.

DESCRIPTION

1. Using white-rot fungi, to break open the lignin-cellulose-hemicellulose complex with minimal degradation of the polysaccharides, and to utilize a range of ntive LC including woodchips, bark and straw.
2. To compare two reactor systems (a) continuously fed fluidized bet reactor (FBR) (b) recirculating tower bioreactor (RTB).
3. To optimize these two reactors for efficient production of free lignin, cellulose and hemicellulose for their further conversion to liquid fuels and chemicals.
4. To select strains of microbes which will be able to co-metabolize lignin to aromatics and phenols.
5. To supply laboratories, working on energy from biomass, with cellulose and hemicellulose derived from LC.
6. To conduct a techno-economic evaluation of the conversion system based on laboratory experience, and the persuasion of chemical companies to investigate the developed process.

STATUS AND COMMENTS

Working in collaboration with A.J. Daugulis.

4.3.9.4 Biomass Materials Handling, Transportation & Pretreatment/Pretreatment. 28/3/82

PROJECT DATA

241

TITLE Evaluation of a One Stage Continuous Acid Hydrolysis Process for Conversion of Agricultural Materials into Sugars

CONTRACT # 01843-1-EL04 (OSZ81-00098)

ORGANIZATION Stake Technology Ltd.
220 Wyecroft Road
Oakville, Ontario
L6K 3V1

PRINCIPAL INVESTIGATOR

DURATION November 1981 - March 1982

COST $72,000

SPONSOR Agriculture Canada

SCIENTIFIC AUTHORITY R.D. Hayes
Engineering & Statistical Research Institute
Building 94
Agriculture Canada
Ottawa, Ontario
K1A 0C6

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$48,000			$48,000
1982-83	$24,000			$24,000

OBJECTIVE

The overall objective of the project is to perform exploratory tests on the patented Stake Technology autohydrolysis reactor using combined steam treatment and a hydrogen ion source such as the infusion of SO_2 on a variety of agricultural materials. Tested for each combination of residence time, temperature and hydrogen ion concentration and process configuration (i.e. single pass or double pass, etc.) the production of fermentable sugar is to be optimized for the production of fuel ethanol. The exploratory nature of the project is to test the above concept so that a decision can be made regarding carry-on studies to establish a detailed technical and economic model.

DESCRIPTION

The contractor will perform preliminary experiments on a batch/bench scale autohydrolysis reactor (approx. 50 g samples) to determine optimum reaction kinetics and process conditions using steam treatment and a hydrogen ion source (e.g. infusion of SO_2 gas or others) for the maximum or optimum conversion of designated feedstocks to fermentable monosaccharides without subsequent enzyme hydrolysis. Designated feedstocks are to include corn grain, corn stover alone, corn cobs, barley grain and barley straw. Sugars from the liquid stream only will be analyzed qualitatively and quantitatively to determine optimum and maximum production of fermentable sugar relative to process conditions and flow configuration. Fermentability studies will be conducted on promising sugar hydrolysates (Note: Fermentability studies refer to preliminary investigations only in a flask or test tube scale to determine if the sugar streams are fermentable (anaerobically, if practical)). The contractor will observe the impact of autohydrolysis on potential protein and oil recovery/degradation on corn and barley grain feedstocks.

REPORTS

STATUS AND COMMENTS

4.3.9.4 Biomass Materials Handling, Transportation and Pretreatment/Pretreatment. 23/3/82

PROJECT MANAGEMENT

PROJECT DATA 102

TITLE Project Management in support of ENFOR

CONTRACT # Separate contracts signed each year (E-1)

ORGANIZATION Forintek Canada Corporation

PRINCIPAL INVESTIGATOR

DURATION 1 April 1979 - 31 March 1983

COST $564,835

SPONSOR Environment Canada

SCIENTIFIC AUTHORITY

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1979-80	$150,000			$150,000
1980-81	$159,330			$309,330
1981-82	$225,505			$564,835

OBJECTIVE

1. To maintain current awareness of biomass energy technology developments with specific reference to needs and activities of the forest industry in Canada.

2. To coordinate, administer and/or manage ENFOR projects, where appropriate.

DESCRIPTION

In 1979-80, 16 ENFOR projects were managed and; in 1980-81, the number was 20. Two and one-half person years of resources are available in 1981-82 to provide technical liaison for 18 projects, to prepare technical reviews, to procure information through inspection and to transfer information as required.

REPORTS

Quarterly reports on activities are submitted to the ENFOR Secretariat but these are not published for public distribution.

STATUS AND COMMENTS

PROJECT DATA 257

TITLE Bioenergy Program Management

CONTRACT # n/a

ORGANIZATION Energy Research & Development Division
National Research Council Canada
Montreal Road
Ottawa, Ontario
K1A 0R6

PRINCIPAL INVESTIGATOR B.A. Summers
(613) 993-1342

DURATION April 1981 on

COST $100,000 to date

SPONSOR National Research Council Canada

SCIENTIFIC AUTHORITY n/a

FUNDING

FISCAL YEAR	SPONSOR	CONTRACTOR		TOTAL
1981-82	$100,000			$100,000
1982-83	$132,000			$132,000

OBJECTIVE

To manage the incremental projects undertaken through the National Energy Program, specifically to provide technical assessment of the program, monitor progress and provide scientific guidance to research contractors.

DESCRIPTION

When new projects in Bioenergy Research were initiated in 1981 under the auspices of the National Energy Program it was recognized that an augmentation to the resources of the Bioenergy Program Office was necessary. Therefore 2 person-years and $100,000 in the first year were provided to facilitate effective program management of in-house research activities and contract research. The resources provided matched those already supplied to the Program Office by NRC A-base resources.

This funding makes it possible for the Bioenergy Program Office to establish the facility to technically assess proposals and reports, and to evaluate technological advancements so as to fulfill the mandate to provide technical advice to the policy staff of Energy Mines and Resources.

The expected outputs are:

1. Timely identification of technology advancement.
2. Immediate access to current status of all projects.
3. Timely achievement of technology transfer via appropriate media.

REPORTS

(in print)
Proceedings of Fourth Bioenergy R&D Seminar, Winnipeg, Manitoba, March 29, 30, 31, 1982.

(in print)
Summary of the 1981 Bioenergy R&D Program, Ottawa, Canada, NRCC # _____, May 1982.

STATUS AND COMMENTS

The Program Office is fully staffed, has automated its project data and has the proceedings of its annual Seminar, and the summary of the 1981 program in print.

B. Summers - May 1982

4.3.10 Biomass Energy/Project Management.

14/5/82

APPENDICES

APPENDIX I

Resource Allocation in Bioenergy Research and Development from 1977 to 1981 inclusive

(expressed as percentage of total annual expenditure)

Program Element	1977	1978	1979	1980	1981
	%	%	%	%	%
Resource Assessment	6.9	12.8	8.9	20.3	15.0
Environmental Effects	-	1.6	5.7	6.4	4.6
International Participation	-	.8	.6	.4	1.4
Planting/Harvesting/Collecting	-	2.4	5.6	13.1	11.2
Conversion Technologies	58.2	55.1	51.2	27.9	33.0
Fundamental Studies	-	13.9	7.9	16.7	18.0
Economic/Technical Assessment	34.9	12.3	16.4	6.4	2.2
Materials Handling	-	1.2	1.6	6.0	10.6
Management	-	-	2.1	2.8	3.9
	100.0	100.1	100.0	100.0	99.9

APPENDIX II

Source of Funding of Bioenergy Research & Development in 1981-82

	($K)	($K)
Interdepartmental Panel for Energy Research & Development through:		
Agriculture Canada	800.0	
ENFOR of Environment Canada	6150.0	
National Research Council	1461.0	
Energy Mines & Resources	650.0	9061.0
Other federal agency resources:		
Agriculture Canada		450.0
Environment Canada		162.4
Natural Sciences & Engineering Research Council		928.8
National Research Council		3447.9
Total direct federal funding of Bioenergy R&D		14050.1

APPENDIX III

Projected 1982-83 Bioenergy R&D Funding

Source	($K)	($K)
1. Interdepartmental Panel for Energy Research & Development		
Agriculture Canada	1335.0	
ENFOR of Environment Canada	7668.0	
National Research Council	1702.0	
Energy Mines & Resources	650.0	11355.0
Plus continuation of base funding at level of 1981-82 budgets by:		
2. Agriculture Canada		450.0
3. Natural Sciences & Engineering Research Council		900.0
4. National Research Council		3400.0
		16105.0

APPENDIX IV

CLASSIFICATION INDEX

SUB-PROGRAM 4.3.1 BIOMASS RESOURCE ASSESSMENT

4.3.1.1 - Forestry - Mill Wastes

4.3.1.2 - Forestry - Logging Residue

4.3.1.3 - Forestry - Biomass Factors

4.3.1.4 - Forestry - Energy Plantations - Productivity

4.3.1.5 - Agriculture - Animal Residues

4.3.1.6 - Agriculture - Plant Residues

4.3.1.7 - Agriculture - Energy Crops

4.3.1.8 - Peat (not included in program after March 1981)

4.3.1.9 - Algae

SUB-PROGRAM 4.3.2 ENVIRONMENTAL EFFECTS

4.3.2.1 - Forestry - Silvicultural and Harvest Impacts

4.3.2.2 - Forestry - Conversion Technology Impacts

4.3.2.3 - Agricultural - Agricultural and Harvesting Impacts

4.3.2.4 - Agricultural - Conversion Technology Impacts

4.3.2.5 - Peat - Harvesting (not included in program after March 1981)

4.3.2.6 - Peat - Conversion Technology (not included in program after March 1981)

SUB-PROGRAM 4.3.3 INTERNATIONAL PARTICIPATION

4.3.3.1 - International Energy Agency "Short Rotation Forestry for Energy"

4.3.3.2 - International Energy Agency "Biomass Technical Information Service"

SUB-PROGRAM 4.3.4 SILVICULTURE

SUB-PROGRAM 4.3.5 **BIOMASS PLANTING, HARVESTING AND COLLECTION TECHNOLOGIES**

SUB-PROGRAM 4.3.6 **BIOMASS CONVERSION TECHNOLOGIES**

4.3.6.1 - Biogas Production

4.3.6.2 - Fermentation to Alcohol

4.3.6.3 - Low Joule Gasification

4.3.6.4 - Medium Joule Gasification

4.3.6.5 - Methanol

4.3.6.6 - Direct Combustion

4.3.6.7 - Char Production

4.3.6.8 - Oil Production - Liquefaction

4.3.6.9 - Chemical Feedstocks e.g. NH_3 (but not including transportation products)

4.3.6.10 - Electrical Generation

4.3.6.11 - Pyrolysis

SUB-PROGRAM 4.3.7 **BIOENERGY - FUNDAMENTAL STUDIES**

4.3.7.1 - Anaerobic Fermentation

4.3.7.2 - Fermentation of Pentoses

4.3.7.3 - Construction of Microbial Strains for Energy Production

4.3.7.4 - Fluidizable Heat Storage

4.3.7.5 - Molecular Models of Photosynthesis

4.3.7.6 - Solar Energy Conversion via Photosynthetic Bacteria

4.3.7.7 - Catalytic Synthesis

4.3.7.8 - Membrane Applications in Gas & Liquid Separations

4.3.7.9 - Biochemical Production of Hydrogen

4.3.7.10 - Oil-Bearing Microbes

4.3.7.11 - Immobilized Cell Techniques for Fuel Production

SUB-PROGRAM 4.3.8 SOCIO-ECONOMIC-TECHNICAL STUDIES

4.3.8.1 - Social Infrastructure

4.3.8.2 - Technology Assessment

4.3.8.3 - Economic Assessment

4.3.8.4 - Information

4.3.8.5 - Legal Studies

SUB-PROGRAM 4.3.9 BIOMASS MATERIALS HANDLING, TRANSPORTATION & PRE-TREATMENT

4.3.9.1 - General

4.3.9.2 - Materials Handling

4.3.9.3 - Transportation

4.3.9.4 - Pre-treatment

SUB-PROGRAM 4.3.10 BIOENERGY PROJECT MANAGEMENT

APPENDIX V

REPORT AVAILABILITY

Throughout this report the location from which reports may be obtained is given as ENFOR Secretariat, CISTI or Energy Library, NRC Publications, or Agriculture Canada. Addresses and telephone numbers of these organizations are given below. A complete listing of all Bioenergy research and development reports available is given in Appendix VI.

The Energy Library, which is a part of the National Science Library known as the Canada Institute for Scientific and Technical Information, is the official repository of all scientific reports produced by or on behalf of the government of Canada. Therefore, two copies of each report of the bioenergy program are supplied to the Energy Library from which they are available through inter-library loans. For information contact:

Energy Library
Canada Institute for Scientific and
Technical Information (CISTI)
National Research Council
Room 29, M-55
Montreal Road
Ottawa, Ontario. K1A 0S2

Phone (613) 993-3861
Telex NRC LIB OTT 053-3115

The ENFOR Secretariat has a limited supply of reports on projects sponsored by Department of the Environment. These reports are available free on request. For information contact:

ENFOR Secretariat
Canadian Forestry Service
Department of Environment
19th Floor
Vincent Massey Building
351 St. Joseph Blvd.
Hull, Québec K1A 1G5

Phone (613) 997-3409

Agriculture Canada reports on microfiche are available free on request from:

Agriculture Energy Research and
Development Information
Engineering & Statistical Research
Agriculture Canada
Building 94
Ottawa, Ontario. K1A 0C6

Phone (613) 995-9671

NRC Publications Office supplies priced publications of the bioenergy program. Requests, accompanied by cheque or money order payable to Receiver General of Canada - Credit National Research Council, should be sent to:

Publication Sales and Distribution
National Research Council
M-58, Montreal Road
Ottawa, Ontario. K1A 0R6

Phone (613) 993-2054 or 993-1996

APPENDIX VI

BIOENERGY R&D REPORTS

Reports are available on loan from the Energy Branch Library Canada Institute for Scientific and Technical Information, National Research Council, Montreal Road, Ottawa, Ontario. K1A 0R6. Reports prefaced with an asterisk are available at nominal cost from NRC Publications, M-58, Montreal Road, Ottawa, Ontario. K1A 0R6.

RESOURCE ASSESSMENT

Neil and Gunter Ltd., A Study of the Potential for Residue/Energy Systems in Eastern Canada Utilizing Wood Residues. Fredericton, N.B., March 1978.

British Columbia Wood Waste Energy Co-ordinating Committee, Hog Fuel Availability in British Columbia. This report is based on a study undertaken by Reid, Collins & Assoc. Ltd., July 1978.

Northern Forest Research Centre, Biomass Productivity of Young Aspen Stands in Western Canada. Edmonton, Alberta, NFRC Information Report NOR-X-219, January 1980. ENFOR Project P-22.

British Columbia Wood Waste Energy Co-ordinating Committee, Hog Fuel Availability Study - South Coastal Region of B.C. Based on a study performed by Reid, Collins and Associates, Vancouver, B.C., September 1978.

Blais, McNeil, Lussier, Tremblay and Associates, Études sur les volumes de résidus du bois disponibles sur le chantier de coupe et à la scierie pour la production d'énergie. Ste. Foy, Québec, December 1978.

THOMAS J.B., Biomass Inventory of Tolerant Hardwoods. Based on a study performed by Arch Enterprises, Sault Ste. Marie, Ontario, December 1978. ENFOR Project P-21.

WELDWOOD Robert W., Ph.D., P. Eng., Part I: Biomass of Forest Tree Components. Part II: Recovery of Biomass. Part III: Utilization of Biomass. A complete-tree utilization: an analysis of the literature (1970-1978). ENFOR Project P-15.

Blais, McNeil, Lussier, Tremblay and Associates, Volume of Wood Residues for Energy Production at Parent. A summary. November 1979. ENFOR Project P-6.

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BIOENERGY RESEARCH AND DEVELOPMENT

A SUMMARY OF THE FEDERAL PROGRAM

April 1981 to March 1982

ERRATA

The Index of Investigators and the Index of Organizations incorrectly refer the reader to the project data sheet numbers rather than to the page on which mention of them is made. Therefore, the attached revised indices have been printed showing the correct reference page numbers.

Please place these in your copy of the program summary.

B.A. Summers
September 1982

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